Instruments

THE MAGAZINE OF Measurement and Control

Vol. 15
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No. 1

SPECIAL ISSUE :: IN TWO PARTS :: PART ONE

READERS' OWN FORUM ON TRENDS AND PREDICTIONS

Where Are We Now?
How Did We Get Where We Are?
Where Do We Go From Here?

Brief Answers from Three-Score Readers
Each Representing an Occupational Field

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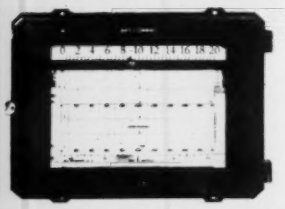

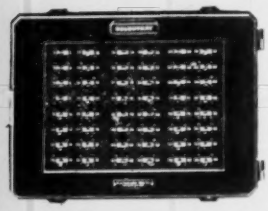

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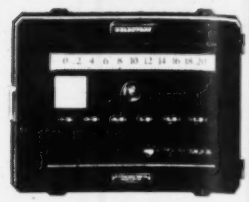
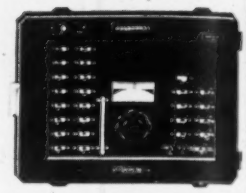




C. J. TAGLIABUE MFG. CO.

Park and Nostrand Aves.
Brooklyn, N. Y.

Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

You Have The Floor

THIS Special Issue is like a good old American town meeting where all townsmen have been invited to come and to speak right out. It is like a successfully lively meeting where diverse topics have been brought up by many townsmen—all talking freely, all talking decorously, all talking briefly and to the point, so that not once throughout the evening did a long-winded or offensive speaker have to have the gavel pounded at him.

Which means that diverse topics have been written up by many readers—all writing freely, all writing decorously, all writing briefly and to the point, so that I had no occasion to throw any contribution in the waste-paper basket. The experiment is such a complete success that nearly seventy editorials follow this page and I really shouldn't write an editorial of my own this time. I won't: This is an informal report.

To be exact, sixty-seven of you have done my usual chore. Thank you, gentlem—beg pardon—thank you, *ladies* and gentlemen!

Ladies? Yes, and as one of them writes at the end of her editorial, "it's only the beginning." Meaning that more and more women will do more and more instrument work now done by men. Furthermore, I didn't merely hope that women-in-instrument-work editorials would drop from heaven: I went after them, for it is obvious that in order to win the war—in order to win it quickly—as much as possible of the enormous amount of necessary instrument work must be done by women.

Only in this respect, however, did I as "chairman of the town meeting" presume to suggest a particular topic: all other editorials are—to quote Clifton Fadiman—"spontaneous and unrehearsed." (My hardest editorial work was to write those newspaper-style three-decker headings without departing from the tone of each author.)

Beside the necessary and ultimately beneficial feminine invasion, another general subject of growing importance is that of education and training. Various phases of it are discussed by nine readers.

Overshadowing all else as a general subject, of course, is the war. Nearly all editorial-writers refer to it, but eleven editorials deal specifically with aspects of the War Effort, and they appear under that heading.

As I went over all manuscripts—some beautifully typed and some evidently scrawled in the field, far away from the office—and classified them by subjects, I discovered that an almost perfect "sampling" of *Instruments* readers was represented by each of several little piles of manuscripts:—the editorials on broad fundamental subjects; those on war production; those which might be called specific reports and recommendations; those disclosing specific ideas; and those making specific predictions.

Under each of these headings, therefore, you will find a group which includes a reader of your own kind—your occupation, your industry, or your geographical section. Certainly you will find your age-group represented among the authors when you see the photographs that were received in time to be published.*

For the perfection of the samplings of readers, credit is due to Publisher Rimbach and the Circulation Department—not to me. They knew from their experience that the notices printed in the November and December issues, inviting all readers to send editorials for this issue, would bring about fifteen manuscripts (and they were right!)—so they painstakingly went over 9000 addressograph cards classified in various ways, and obtained a scientifically correct sampling of about 450 names and addresses—to which personal letters signed by me were sent.

The proportion of instrument-company authors in this issue is much higher (about twenty times higher) than among *Instruments* subscribers in general. Guess why? You are right: Not only did most of those who happened to receive a personal invitation send manuscripts, but some hastened to take up the open invitations printed in the November and December issues. But there is a second reason, of deeper significance: these instrument-company men considered it a privilege to address a town meeting where the audience is made up of you and you and you. The care with which they prepared their editorials is a tribute to you as well as a sign of discriminating judgment on their part.

Several manuscripts submitted for publication in this issue do not appear: I held them out to get the authors to expand them into full-length illustrated technical articles. Watch for some great "exclusives."

Although I did not "reject" any of the returns, there are about sixty which do not appear because they were letters rather than editorials, all of them heaping praise on *Instruments* and on me. By the way, in editing the pieces that *are* published on the following pages, I cut out all complimentary remarks except those that could not be deleted without taking undue liberties with the authors' statements on other subjects. At this time, when I expect to be put back on full-time Army service (perhaps thousands of miles from Pittsburgh), it is heart-warming to get such a nice send-off. All I can say is that I don't deserve these compliments and that *Instruments* will continue to be just as valuable to you when it has to be published without.

M.F.B.

*Don't you think those politicians have a nerve claiming that platinum-haired Federal Security Administrator McNutt is the handsomest man in public life? Professor Williams (page 34) has McNutt beaten forty ways from Sunday for looks. Do I hear a motion to run "Williams for President" in '44? . . . Unanimously carried!

American Society for Measurement and Control

Electric Telemetering will be discussed by Perry A. Borden of the Bristol Co. at the February meeting, Bureau of Mines Auditorium, 4800 Forbes St. (near Tech) Monday, February 16 at 8 sharp. All welcome. Ample parking space in back of Bureau buildings.

Announcing
Another
Aviation
Issue
March 1942

Chicago Society for Measurement and Control

Refinery Instrumentation will be discussed by Vaughn Ischie of the Sinclair Refining Co. at the February meeting, Monday, February 9 at Paul Smidt's. Dinner ($1.25) at 6:30, meeting at 8 sharp. Come to the meeting if not to the dinner. Carl Hope, Exec. Sec'y, 2626 W. 31st Blvd., Chicago.

Sixty-seven Typical *Instruments* Readers Editorialize
1—INSTRUMENTATION IN GENERAL
With EMPHASIS on Its FOUNDATIONS

Research Laboratories Are a Necessity, Not a Luxury

By LYMAN J. BRIGGS
Director
National Bureau of Standards
Washington, D. C.

WE are all now trying in the course of a few months to invent and develop instruments and equipment which should have been developed months ago. I hope that when we come out of this war industry and the Federal Government will be finally convinced that research laboratories are a necessity, not a luxury.

We shall be faced at the end of the war with the most severe industrial competition the world has ever known. Our ability to meet this will be measured by the support given to research laboratories to develop new discoveries, new facts upon which new industries can be founded.

Gives Examples of Instrumentation's Benefits

By T. H. SPRINGSTEEL
Instrument Department
The Texas Company
Craig, Colo.

WHAT would the U.S.A. be today without instruments? Can you run an automobile, airplane, tractor or a factory without knowing and governing your speeds, oil pressures, r.p.m., flows or temperatures? Without instruments they would end up in a junk pile. In my line of work my experience has been with electric instruments such as k.w.h. demand and p.f. meters; also, I maintain and operate pyrometers, flowmeters, temperature controllers, flow and pressure controllers and liquid level controls of the open and shut type; also the reset type which is the only instrument for real accurate control and precision workmanship.

Just the other day instruments solved a real difficult problem. It happened to be a split flow to a unit which the liquid had to be exact to the gallon in order to maintain equal temperature at the two outlets. This job only has one duplex pump pumping into a single line for several feet; then the line branches off into two different directions. Each has an orifice meter. Also the main line has a rate of flow controller into it. Well, instead of operating the r.f. from the steam end of the pump, we installed two V-port direct-acting valves into the dual flow lines and paralleled these valves with the r.f. controller. By doing this the valves synchronize with the instrument air, the flow and pressure are correct and the results are perfect. We also installed a pressure control on the steam end to hold constant and uniform pressure on the discharge line, which also serves as a safety point as you don't get excess pressure at any time.

Without instruments, products couldn't be made uniform, airplanes couldn't be balanced and engines couldn't run smooth. I say to all of you, more power to instruments. They are a wonderful invention.

Instrumentation's Level of Precision Rises; Its Areas Widen

By H. W. GRAHAM
Director of Metallurgy and Research
Jones & Laughlin Steel Corporation
Pittsburgh, Pa.

A CONDITION of tremendous interest and encouragement to readers of *Instruments* and to all scientists and technologists is this fact: As the years pass instrumentation is reaching a continuously higher level of precision and a tremendously broader field of coverage. It is not necessary to conclude that a given effort will fail today because it did fail in years past. Today in every field of measurement, evaluation, and control things are possible that were a decade ago baffling and partly or wholly impossible. This fact is an inspiration to move energetically against the tasks that face this nation; and, as success succeeds, the improved position of today will make sure even more rapid progress in the future.

"After This War We Have a Big Job to Do"

By WALDO H. KLIEVER
Engineer-Physicist
Minneapolis-Honeywell Regulator Co.
Minneapolis, Minn.

AN engineer-physicist is naturally interested in the application of science to industrial problems and eventually to better living. But your question, "Where do we go from here?" is not answered by saying that we shall soon have private helicopters and television and homes with radiant heating filled always with fresh country-like air having just the right number of ions, and that we shall have better machines to lessen our labor and improved drugs and diets that make for longer and more vigorous life. The answer seems to depend on other things that have lagged behind our material progress.

Our immediate future is clear. We must all work together to win the war. It is encouraging to travel over

this great country and see the evidence of its might in the enormous new industrial plants that are growing up so quickly. We have allowed certain base ideals to become prominent in this world and it is unthinkable that they should come into general control.

After this war we have a big job to do. There must not again be a peace of hate and spoils. Isolationism is an illusion. Scientific thought and the Golden Rule must be applied to national and international social and economic problems. Then all people shall have easily and abundantly the things for which they now fight. Then further technical developments will be justified by their benefits to mankind.

There is reason to be hopeful. There is evidence of much clear thinking in this line. But scientists and engineers and manufacturers, individually and collectively through their societies, must take active responsibility beyond their daily work. Technical men have a right and duty to be interested in the use of their developments after they leave the laboratory.

Four Youthful Offsprings of Science Provide New Testing Methods

By WAYNE T. SPROULL
Physicist
General Motors Research Laboratory
Detroit, Michigan

BETWEEN 1895 and 1900 the science of physics was revolutionized by two discoveries—x-rays by Roentgen and the electron by Thomson and others. The necessary earlier scientific groundwork had been laid by such physicists as Faraday, Helmholtz, Maxwel, Zeeman, Lorentz, and many others.

Many of the technical developments of this century have sprung from these discoveries of pure science. Such examples as the radio are known to everybody, but others are not, among them:

(1) Best-known of the four is industrial radiography. The practice of x-raying castings and welds to reveal hidden flaws was almost unknown to industry until 1925, and it was not until 1940 that million-volt radiographic equipment capable of work on steel 5" thick appeared on the market—just in time for use in inspecting heavy armor plate and parts for huge tanks and cannon. This amazingly compact million-volt equipment seemed to represent the ultimate; the "practical limit" had been reached.

This year, however, the "practical limit" suddenly receded several miles when physicist Donald W. Kerst announced an entirely new method of making electrons produce extremely penetrating x-rays.[1,2] His revolutionary new betatron produces 20-million volt x-rays of great intensity, and its size and cost should be no greater than the present million-volt equipment.

(2) In 1912, Laue, Friedrich and Knipping discovered that the wave characteristics of x-rays made them useful for studying the atomic structure of crystals and molecules. This powerful new method was not applied in the industrial world until about 1925. Now many manufacturers of defense equipment are buying modern x-ray diffraction outfits to check heat treatment, determine grain size and orientation, and solve many knotty metallurgical problems in their defense production.

[1]D. W. Kerst. Induction Electron Accelerator. *Physical Review*, Vol. 59, 1941, pages 110-111.
[2]D. W. Kerst. Radiation from Induction Accelerators. *Physical Review*, Vol. 59, 1941, pages 933-934.
See also *Time*, Dec. 29, 1941, page 44.
See also: T. H. Osgood. Physics in 1941. *Journal of Applied Physics*, Vol. 13, Jan. 1942: section VI, pages 14-15.

(3) In 1926, H. Busch proved[3] that a coil of wire could be used to focus an electron beam just like a glass lens focuses a light beam. By 1932 Knoll and Ruska[4] had used this principle to construct the first electron microscope—a laboratory model. In 1940 an electron microscope[5] was placed on the market in this country, which enabled men to see clearly objects only one tenth the diameter of the smallest visible with the best optical microscope, and it is certain that the limit of this development has not been reached.

(4) In 1927 Davisson and Germer discovered[6] that electron beams have wave characteristics instead of being limited exclusively to the characteristics of particles as previously supposed. This phenomenon has already been used to study fundamental problems encountered in such industrially important fields as electroplating, corrosion, polishing, thin surface films, and lubrication. This fifteen-year-old scientific offspring is still knocking at the door of most industries. Nobody has even offered an electron diffraction outfit for sale for industrial work in this country to date.

Where do we go from here? Well, at any rate, we aren't there yet!

[3]H. Busch. Berechnung der Bahn von Kathodenstrahlen im Axialsymmetrischen Elektromagnetischen Felde. *Annalen der Physik*, Vol 81, 1926, pages 974-993.
[4]W. Knoll and E. Ruska. Das Elektronenmikroskop. *Zeitschrift fur Physik*, Vol. 78, 1932, pages 318-339.
[5]V. Zworykin. The Electron Microscope. *Instruments*, Vol. 13, June 1940, page 151.
[6]C. Davisson and L. H. Germer. Diffraction of Electrons by a Crystal of Nickel. *Physical Review*, Vol. 30, 1927, pages 705-749.

Discovery and Instrumentation Are Co-partners In Scientific Progress

By S. R. WILLIAMS
Professor of Physics
Amherst College
Amherst, Mass.

IN 1819 Oersted performed the simple experiment of passing an electric current through a wire which was stretched parallel to a compass needle. So long as the electric current flowed in the wire the magnetic needle was deflected away from its position parallel to the wire and when the current ceased the needle resumed its former position.

In that discovery of a circular magnetic field surrounding an electric current, Oersted pointed the way to our modern ammeters, voltmeters and galvanometers. He introduced our modern era of electrical instrumentation. Oersted demonstrated what everyone has observed who has taken part in the building up of a branch of science: that new discoveries lead to new instrumentation and with improved instrumentation we are led to new discoveries. It is a benign circle.

Oersted's discovery led to the galvanometer, but how would Faraday have discovered the phenomenon of electromagnetic induction without the galvanometer? Faraday's discovery was the forerunner of our modern electric light and power developments. In the simple experiment of thrusting a magnet into a coil of wire and producing an electric current, Faraday did on a small scale what the big generators at the Boulder Dam are doing, day by day, year in and year out.

Can anyone doubt the need for improvements in our present program of instrumentation? We make progress when we lift ourselves out of the realm of guess-work into that one where quantitative measure holds sway.

Well did Lord Kelvin state the matter when he said: "When you can measure what you are speaking about, and express it in numbers, you know something about it; and when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the stage of a scientist."

Optical Institute Is Suggested and Its Functions Listed

By KEIVIN BURNS
Astronomer
Allegheny Observatory
Pittsburgh, Pa.

THIRTY-SEVEN years in spectroscopic work and related fields leave me hesitant to make general suggestions but I believe I am not alone in discerning a growing need for an Optical Institute for Pittsburgh, either independent or a part of a national organization. Among the purposes of such Institutes would be the following:

To teach men and women to figure lenses, mirrors, and prisms, and to assemble and test optical apparatus.

To train workers in the use of optical instruments.

To introduce optical devices and methods which are well known into every place where they can be of value.

To devise improved machinery and apparatus for making and testing optical apparatus.

To study and teach optical design.

To adapt optics to new uses in war and industry.

To develop the optical glass industry by improving methods of production and by the introduction of types of glass not now made in quantity in America, and by producing entirely new types.

More specifically: The production of a simple and effective vacuum spectrograph, and the development of infrared technique; both for use in steel analysis (though useful in other connections).

Institute for Instrument Research Is Outlined

By RALPH HOLCOMBE MULLER
Chemistry Dep't, New York University
Chairman N. Y. Section Am. Chem. Soc.
New York City

THE NATIONS that will survive the present conflict with a reasonably intact industry and economy are those which most profitably absorb the lessons of the last war. An independent American chemical industry dates from that war. Today it is the largest in the world. With an initial minimum of governmental protection, it achieved its preeminence by the only logical method—research and more research. The American instrument and apparatus industry received a similar stimulus and some degree of independence during the same period.[1]

The present all-out effort in industry will absorb all available instrumental applications. It is axiomatic in the applied sciences that application soon outruns fundamental developments. It is quite certain that industry as well as pure science will make unprecedented demands for new and still better instruments.

We are now at war, but even the preceding defense effort revealed two glaring deficiencies: (1) Inadequate instruction in instrumentation; (2) the need for fundamental research in instrumentation. Even in a single field, it is remarkable to note how many capable investigators are not fully acquainted with the measuring and instrumental resources of their own subject.[2] In all fairness, it is expecting too much of them to include, over and above their acquaintance with the latest developments, a full appreciation of instruments and all the chemical, physical and engineering specialties which are involved in their design.

It would be foolish indeed to ignore the encouraging and pioneering efforts which have been made in this direction. This journal and the untiring efforts of its editor have been responsible for a widespread realization of the value of instrumentation. Lecture courses have been established, and local societies have stimulated the free discussion of instrument topics. Many engineering schools include a course or two in the subject. We must do more than this. We must elevate the subject from the status of accepted and proven value to one of recognized professional position where its unselfish prosecution of research will be respected by the academic world and its useful contributions will be increasingly indispensable to industry.

The instrument industry, as it is constituted today, cannot afford extensive and time-consuming research. Its research efforts are perforce restricted to matters of improvement and development. On the other hand, the individual investigator is not too well equipped for instrumental research and his new apparatus is often a makeshift compromise. The instrument manufacturer seeks all possible outlets for his device. The research man or engineer, of necessity, cares only about its suitability for his purpose.

Is there any reason why a *new* instrument should evolve so slowly and then encounter so many vicissitudes before its use really becomes widespread? There are countless examples in the chemical field where the adoption of a new instrumental method has taken years, either due to a lack of information concerning its possibilities and limitations, or due to incomplete instrumental development and perfection.

The answer would seem to lie in an Institute for Instrument Research affiliated with a large university and partly supported by industry. It is conceivable that some of our more progressive institutions would recognize instrumentation as a legitimate field for the granting of higher degrees and that industry could profit by supporting long-range fundamental investigations. An Institute of this character would be charged with the accumulation, correlation and dissemination of information on instruments and the methods of measurement. It would give degree courses in the theory and applications of instruments and the principles of automatic control. It would also support fundamental research in the science of physical measurement. Industrial participation and support would be forthcoming if it could be shown that the Institute would eventually provide a source of competent specialists able to carry their experience into the industrial world. Industry could also exercise a proprietary interest in the venture by the establishment of fellowships for the study of its own problems.

We need a group of investigators to appraise and study the future possibilities of instrumentation, unfettered by prejudice or the urgent need to sell its wares. We have those who at present supply us with very good tools, but we need an intermediary to supply them with new ideas, to create new instruments and to devote full time to such matters so that instruments shall not continue to arise by accident or as a by-product of some urgent need. A venture of this kind would be entirely supplementary to the instrument industry and in no wise competitive. It would seek to assume the burden of public instruction and education and in its research capacity to undertake those intriguing and usually "unprofitable" inquiries with which no true science can dispense.

We shall have repeated occasion to be proud of our American instrument industry in the trying days to come but it would be a disservice if we failed to recognize its needs, and to support it with our best resources.

---

[1] R. H. Muller, American Apparatus, Instruments and Instrumentation. *Industrial & Engineering Chemistry, Anal. Ed.*, Vol. 12, 1940, pages 571-630.

[2] R. H. Muller, Instrumental Methods of Chemical Analysis. *Industrial & Engineering Chemistry, Anal. Ed.*, Vol. 13, 1941, pages 637-754.

2—THE WAR EFFORT

Instrumentation CAN Speed Up Production with Fewer Men

By C. O. FAIRCHILD
Director of Research
C. J. Tagliabue Mfg. Co.
Brooklyn, N. Y.

BY "fewer men" the writer means, of course, fewer man-hours per carload or other unit of factory output. A possibility is the "manless factory" but it is beyond reach—for even if a manless artillery shell factory, for example, could be roughly laid out on paper, it might take two or three years to be designed in detail and another two or three years to be built. Therefore the great need is for ways and means which are immediately applicable. One of the best statements of this general principle was made in the editorial in the January 1941 *Instruments*, entitled, "Defense Will Be Speeded Up":

> The most valuable ideas are those which are immediately applicable . . . Instruments, meters, automatic control systems, automatic inspection set-ups, etc.—these are not factories to be built, mines to be dug; they are readily-available products. Even an entirely new instrument or automatic system is in most cases made up of readily-available components.

From this general principle there may be derived numerous detailed instructions. If time and space permitted, several pages could be filled. The following list is limited strictly to suggestions arising from the writer's personal observation.

1. War industries are not yet using enough of the particular classes of instruments which *can* speed up production—such as automatic controllers. At this writing (early January) even the normal capacity of the instrument manufacturers has not been reached. This means, roughly, that only about 50% of their three-shifts-a-day capacity is being utilized. This means, further, that there are still tens of thousands of applications where the installation of *available* industrial instruments could speed up the production of military and naval items.

2. Industrial instruments—particularly control systems—should be maintained in good condition. This means first of all that they should be under the care of trained instrument men. Unfortunately, there are too many instances where even the most competent management has ignored this principle and has allowed trained instrument men to go. There have even been cases where a manager with jurisdiction over an instrument department has ordered a reduction in the personnel of the instrument department, so that it became humanly impossible for the remaining instrument men to do the required work. Instrument departments should be expanded, not reduced. Small plants without instrument departments of their own should make arrangements for frequent and regular calls by service men from the nearest instrument-company branch factory, or from the nearest "recognized" instrument service company.

3. Whenever new instruments are being ordered, standard designs should be specified, not special in any way even as to scale range, unless the special feature is as urgently required as any item assigned an A1-A priority. Time will be saved if purchasing agents are provided with alternatives along with the original requisitions.

4. The highest priorities are given without red-tape difficulties to industrial instruments for new plants and for plant additions, but this means that a request must be made in each instance. Do not forget to make such a request!

"There Will Be Lasting Benefits in Peace-time"

By G. P. BOSOMWORTH
Manager Engineering Laboratory
Firestone Tire & Rubber Company
Akron, Ohio

TODAY'S acute shortage of technically-trained personnel cannot be ended overnight, but it can be alleviated by extending the usefulness of the men already available in today's War Effort plants. Such plants, both in industrial centers and in agricultural areas, find it impossible to obtain the old-time craftsmen in sufficient numbers, but their problem is being lessened in no small degree by instrumentation of machines and processes. Many of these processes are strange not only to employees but also to manufacturers who have stepped out of their accustomed roles to handle War Effort items.

The use of instruments helps to expedite the training of unskilled workers and minimizes technical supervision. In fact instruments can be considered as an extension service of the technical staff of a factory, acting as agents for them in the field. There is no doubt that instruments have opened the door to War Effort work for many people who would not otherwise have had the opportunity to share in it.

Government specifications which require checks during manufacture and performance tests after completion have introduced the science of measurement and control in many places where it will have lasting benefits in peace-time.

Modern Instruments Double Manpower's Productiveness

By CHARLES E. DIEHL
Chief Electrician
Utah Idaho Sugar Company
Toppenish, Washington

TYPICAL of the general industrial progress is the increased production exhibited in the Sugar Industry. During the last two decades sugar mill efficiency has developed from approximately half a ton of beets processed per man-hour to one ton per man-hour. Instrumentation has contributed the major part to this. Its applications can be classified into four general groups: (a) Temperature control, (b) pressure control, (c) tank or bin level control, (d) chemical evaluation. There is little new in the first three groups; however increased application and more efficient instruments have emerged. In the last field, the control of chemical reactions is just starting to produce results.

In the battle for Democracy more and more manpower must be released for direct military use and less will be available in industrial production as based on the unit quantity produced per man-hour. Instrumentation will do it. Also we must realize the marked effect it will have on factory personnel. No longer is the monkey-wrench mechanic able to repair equipment and keep operation continuous. Trained men are of paramount importance—men educated in the application and maintenance of automatic

control, indicating and integrating instruments. *Instruments* is doing a great work pioneering the importance of training in this field. Industrialists have been prone to accept new instruments, install them and suffer disappointment in the failures resulting from lack of intelligent operation and maintainance. They are just beginning to see the light. The next decade will bring forth enormous development in these fields.

Automatic Inspection and Standardization Advocated

By THOMAS F. GITHENS
Mechanical Engineer
Cleveland Twist Drill Co.
Cleveland, Ohio

TODAY'S urgent need is production and more production. But this production must be of higher and higher quality and precision. Inspection must be ever more thorough and more speedy. If a piece can be made on an automatic screw machine at a rate of ten per minute, it is obvious that the inspection cannot be manually done at slow speed and higher cost. The inspection as well as the production must be automatically done at high speeds. It is possible that much inspection can be done on a piece-work payment basis. The cost of measurement and control must be kept down, the accuracy and effectiveness must be raised.

Another thought closely related to Measurement and Control is that of Standardization. Standard parts, tools, and measuring instruments should be used whenever possible. Standard parts can be made by mass production methods at low costs, and will interchange universally. Special parts are high in cost and of no use on other jobs or other locations. In general Standard parts are more apt to be of good manufacture and require less inspection. Standard instruments and gages are more easily obtained. The publications of the American Standards Association, Bureau of Standards, engineering and technical societies, and manufacturers' and trade associations, should be studied for the best commercial Standards practice.

Save Mercury and Reclaim It for the War Effort

By EUGENE BAINBRIDGE
Instrument Man
Cities Service Company
East Chicago, Indiana

EVERY material is becoming more and more important as our nation goes into an all-out War Effort to defeat our enemies. Mercury, a relatively expensive liquid in peace time, is unobtainable without highest priorities. It may have been handled carelessly in the past, but it must be handled with increased care now. This is an obligation we owe to our country, to do our part in conserving necessary materials.

When mercury has been spilled, an aspirator built with a rubber tube connected will easily pick up the spilled liquid. Dirty, contaminated mercury can be cleaned easily in the following manner: First, if it is oily, remove oil by placing mercury in a closed container with some solvent (such as benzine) and shake, then remove solvent and oil which will be on the top of mercury. Then follow with successive washes of dilute nitric acid (a 20-80 solution will do) and clear water. This will tend to remove any foreign matter resulting from amalgamation. Then, to remove excess water sift mercury through a filter paper placed in a funnel with a small pin-hole in the paper at the spout. The mercury will flow through the hole while the paper absorbs the moisture. In cases where extreme purity is desired the mercury should be redistilled as explained in various handbooks. In many cases, however, filtering through a chamois cloth after aspirating from the floor may be sufficient.

Calls for Intelligent Coöperation In War Effort

By B. H. BRISTOL
Vice President
The Foxboro Company
Foxboro, Mass.

WE have to give all the help we can in the form of intelligent cooperation. Our contact with the various government agencies has given us a feel of the magnitude of the job the officials at Washington are undertaking, as well as a firm belief that the vast majority of government personnel are doing a sincere and honest job. They will cause us many headaches; that is not their intention, however, but is the result of either lack of experience or trying to find the answer to a great many very difficult problems. Active appreciation of this picture will breed confidence both ways and give industry a much stronger voice in court.

The outcome of the present conflict depends on a lot of factors beyond our comprehension but I believe we all can agree that the sooner it reaches an acceptable conclusion the better. This can only come about through intelligently facing the problems and all getting behind those responsible for working out the solution, recognizing the fact that there will be mistakes which will hurt. The important thing is not to harp on the mistakes but, rather, to profit by the knowledge gained and to use our influence to avoid repetitions. I know how hard it is to be tolerant when trying to get materials under priorities or waiting for a Government contract but these hardships are beyond our control, so let's make the best of them and go forward.

Need of Instruments and Measurements in War Effort

By EVERETT S. LEE
Engineer, General Engineering Lab.
General Electric Company
Schenectady, N. Y.

THE need of the hour is that we make more units from a smaller quantity of essential materials. This is engineering, and will require the greatest of ingenuity, together with measurements, and measurements mean instruments; so, Major Behar, your question "Where do we go from here?" is most timely.

All along the line—directive, creative, productive—we must move forward with the fundamental thought in mind of making more units from a smaller quantity of essential materials. And here measurements and instruments abound.

The executive knows of the situation from the reports

which are brought to him as a directive guide. These reports are measurements. Without them he would be lost.

The engineer will need to know, better than ever before, the characteristics of materials, that he may use and place them to greater advantage than he has ever been called upon in his past experience with our accustomed abundance of materials. Laboratory measurements and instruments are his necessary tools for evaluation of materials and product-performance. And as he wisely includes instruments in the design of his final product, they play their part, which can be realized in no other way, in giving performance control for optimum results.

The application engineer will have to use measurements more abundantly so that the completed products are wholly suited for the purpose intended and so that the quantities are completely suited to the needs, with no malapplications.

And the production engineer must have available throughout, materials-testing instruments, dimension gages of all kinds, and process control instruments, so that every bit of material used in product fabrication will be productive, with spoilage and waste consistently reduced.

That's where we must go from here, Major Behar, so that we make more units from a smaller quantity of essential materials. And instruments and measurements take their place most prominently in the process, for they are fundamental to it. Lord Kelvin's incomparable statement, that when you can measure it you know something about it, applies most vigorously here where the need is so essential and so great.

We are most fortunate that the measurements engineer working in the past has made these measuring instruments available for the task. As they have been used in the past, their extended use is even more essential now; and as new ones are needed, they are being provided.

The uses of instruments and measurements are so fundamental it is always a pleasure to speak for them as, in speaking for them, one speaks of a service rendered.

Research Instruments and America's War Effort

By ROY W. BROWN
In charge Aviation Products Research Div.
Firestone Tire & Rubber Co.
Akron, Ohio

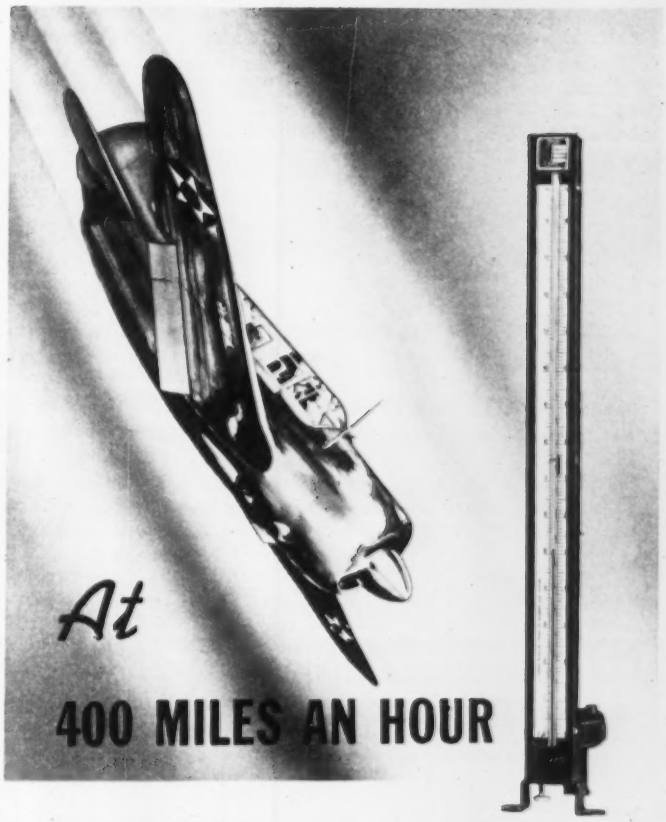
INTENSIVE utilization of mechanical equipment incident to modern armament is of the first importance. Since but a small portion of armament mechanisms are fully automatic, effective utilization is dependent upon the capabilities of the operating personnel. Researches on riding comfort, fatigue and other human factors entering into motor car operation have produced a number of instruments of seeming significance in the use of military mechanisms.

Some years ago Dr. F. A. Moss[1] established the relationship between human fatigue and the vibrations which occur in a motor vehicle. A description of the instruments to measure the vibrations as they occur in the vehicle was recently published.[2] Thus the research engineer is now provided with equipment to measure both the mechanical vibrations and their effect upon the human anatomy. In this manner the problems of efficiently operating under disturbing conditions and for long periods of time can now be studied on a logical basis.

The Society of Automotive Engineers through their Riding Comfort Research Committee has sponsored the evolu-

[1]Consult Research Division, Society of Automotive Engineers, for list of references.

[2]R. W. Brown. Present Status of Instruments for Measuring Riding Comfort. *Instruments*, Vol. 13, April 1940, pages 103-109.



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tion of principles of measurement as well as a number of specific instruments. The Firestone Tire & Rubber Co. have evolved a method of integrating or totalizing the large number of vibrations which occur in a motor car over short distances of even a mile or so. This instrument, known as an electronic integrating accelerometer, gives a single numerical value at the end of test run, indicative of the accumulated forces to which the passenger has been subjected. By laboratory determinations, fatigue and discomfort indexes have been established which enable a predetermination of personnel efficiency when vibration conditions are known.

Human nature being what it is and the instruments being of a research rather than a practical nature, the overall problem is one which requires most expert consideration. Combination of medicine and engineering in a common research project has always been difficult. The subject obviously is one which merits our most serious consideration. It is felt that the researches mentioned provide a groundwork which can be used to better evaluate personnel limitations and, therefore, provide a better working basis which will result in the best possible utilization of the enormously complex mechanical elements of the War Effort.

"Horsepower on Wings" Figures of Interest to Instrument Men

By Lt. Colonel C. H. MORGAN
Ordnance Department, U. S. Army
Wright Field
Dayton, Ohio

AS an engine of destruction, the modern pursuit fighter is truly impressive. It is interesting to analyze aircraft machine guns and automatic cannon from the viewpoint of single-cycle internal combustion machines having an infinite piston displacement. Such a study indicates that the guns possess marked efficiency as engines and the aggregate horsepower of the total armament reaches surprising proportions.

Efficiency may be gaged as the ratio of output energy to potential energy of the propellant. Thus, for the smallest caliber aircraft machine gun, the energy for one round may be determined from the conventional formula $MV^2/2$ where V represents the muzzle velocity. Applying to this result the cyclic rate of fire in shots per second, an output of 127 h.p. is obtained which, compared with the potential energy of the propellant, 487 h.p., shows an overall efficiency of 26%.

New types of rapid-firing automatic cannon develop greater operating efficiencies. The range of aircraft weapons compares favorably with other type engines as indicated by the following approximate tabulations:

Type	Efficiency
Steam engine (turbine)	16% to 30%
Gasoline engine (4 cycle)	22% to 28%
Diesel engine (2 cycle)	32% to 38%
Aircraft weapons (1 cycle)	26% to 37%

A few years ago, the pursuit fighter carried a power plant of some 800 h.p. and was armed with one light and one heavy machine gun comprising an additional 500 h.p. or a total of 1300 h.p. for both power and armament. The pursuit fighter of today has a power plant more than twice as powerful, but the greatest increase is reflected in the augmented armament. The present striking power is many times the feeble armament carried by the older planes. Increases in caliber of weapons and greatly increased muzzle velocities have resulted in a ten-fold increase in horsepower of armament installed. Combining the power plant and armament, the pursuit plane of today carries into combat some 6,000 horses of roaring, fighting fury.

World War No. 2 Is Termed a "War of Instruments"

By H. P. SPARKES
Mgr. Meter Division
Westinghouse Electric & Mfg. Co.
Newark, N. J.

AT the close of World War No. 1 there were many devices of an instrument nature in the development stage that were never used. World War No. 2 has brought out so many new measurement and control devices that even an ideally efficient Intelligence Bureau could not compile a complete list. Mobile units and scientific developments now being used rely on instruments to indicate existing conditions, to calculate desired knowledge, to communicate knowledge and to control the accuracy of operations. Therefore, we might term World War No. 2 a "War of Instruments."

Gives Several Brief "Keep 'em Rolling" Suggestions

Author's photograph not received as this issue goes to press

By G. C. STAUFFER
Technical Assistant to the Vice President
Driver-Harris Company
Harrison, N. J.

IF we are to "Keep 'em Rolling" we must increase production, improve quality and at the same time conserve many common raw materials. The intelligent application of instruments can give us a sure guide to all these objectives.

More accurate control of temperature in diverse operations may achieve all of these. Reducing acid evaporation in pickle tanks by maintaining the optimum temperature is an example. Don't dump those pickle baths just because they seem to be slowing up. Know their condition. Titration sets are easy to operate.

Gas analysis of controlled atmospheres in furnaces can be made by anyone. You don't have to guess.

Quality control is usually achieved by standardized tests with commercial apparatus. If you have a special problem see if you can adapt a standard instrument to meet your requirement. If this is not possible, try "rolling your own." After all, every standard commercial instrument was originally made for a special job.

Your own brain is the most important instrument in the shop. Use it!

The American Red Cross

NEEDS

Your Contribution

3—SPECIFIC IDEAS

Suggests We Start an Instrument Loan & Exchange Dep't

By JAMES L. WATSON
Engineer
Portland General Electric Co.
Portland, Oregon

HERE is one idea which may be useful in 1942. I had the privilege of going through the local shipyard the other day and noticed that too few instruments are used. In some instances the need is obvious. This situation is undoubtedly due to the war shortage.

Why couldn't your magazine operate a loan department, at least for the duration? Many older firms have numbers of old and new unused instruments which could be adapted to new and important applications. You could use one page per month for listing donations and inquiries.

To start you off, I have a Westinghouse Type SM indicating wattmeter, back-connected, 5 amp. 110 volt, 3-phase 3-wire, and will make a scale to fit new conditions for anyone who can use it on war work.

"Controllability" of Processes Can Be Compared

By H. L. MASON
Director of Research
Taylor Instrument Companies
Rochester, N. Y.

ONE of the barriers to a freer interchange of ideas on automatic control in the process industries has been the absence of a common denominator for comparing processes. The dairy operator with a continuous pasteurizer to control has found it difficult to see how the experience of an oil company with its fractionating towers or a chemical company with its reaction kettles can be of any use to him. At the December meeting of the A.S.M.E., however, a paper by J. G. Ziegler and N. B. Nichols proposed the use of a simplified test on an uncontrolled process as a method of approximately defining the amenability of that process to automatic control. Instrument men can thus speak of a "0.2 min. lag, 1.1" per min. unit reaction rate" process, and make a rough prediction as to how such a process will behave when subjected to controller action with a specified setting of proportional response. Equipment designers and process operators can compare controllabilities for the milk pasteurizer, the canning retort, the sugar evaporator, the pulp digester, the fractionating column, the re-boiler, the constant humidity room, the acidulating bath, the degreasing outfit, the soldering machine. Lessons learned painfully and slowly on one process can be applied to another—lessons on the where and how of improvement—locating the sensitive element, altering thermal capacities, specifying the valve, providing additional responses such as reset and Pre-Act, and tuning the controller to the process. New personnel can be trained more quickly, new equipment can be started with more confidence, old operations can be made more efficient. I believe that the process industries have barely begun to tap the resources of cooperative study with respect to process controllability.

Uses of Recorders, &c. in Plant Making Conveying Equipment

By W. J. HEACOCK
Electrical Engineer
Link-Belt Company
Chicago, Ill.

WHILE our particular problems in instrumentation at our Pershing Road Plant do not carry us into processing or timing studies we do find a wide variety of uses for instruments of many types.

Typical of the uses to which we put instruments we might cite the following:

For quick and easy tests to determine the load on a motor if of fairly steady nature the clamp type ammeter is suitable, especially if the motor is fully or over loaded.

For testing for division of load and checking calculations for a dual motor belt conveyor drive, we use a recording ammeter on the secondary drive (since the load on motor is practically constant regardless of conveyor load) and a recording wattmeter on the primary drive as this motor takes all the fluctuations in the loading which may cause it to carry anywhere from a maximum load as a motor to a small regenerative load.

Duty cycle applications are generally checked by means of a recording ammeter.

Counterweights for rotary dumps are checked and improved by the use of recording wattmeters.

Sometimes a recording voltmeter produces the necessary evidence disproving an apparent overload.

A thermometer sometimes proves a motor not excessively loaded on a duty cycle.

Careful tests are made by means of an analyser to obtain data as a basis for future installations or to check our methods of calculating loads on new types of equipment.

Most spectacular is the use of a Strobotac to study gears or chains or the deflection of shafts under operating conditions while they are in motion. This instrument has paid for itself many times over in pointing to the solution of difficulties encountered.

Radiation Pyrometers Guard Refractories, Boost Production

By W. M. DOUGLAS
Pyrometer Supervisor
Inland Steel Company
East Chicago, Indiana

THE modern total-radiation pyrometer is a tool which can be used to great advantage by industries employing high temperatures in their processes.

It is especially valuable when used to indicate and record temperatures of refractories in regenerative checker chambers such as the open-hearth furnace checker chambers and blast furnace stoves.

The open-hearth furnace checker chambers can be maintained in balance thermally and can be operated at a higher temperature without danger of damaging the brickwork when total-radiation equipment is properly applied and

used. Open-hearth operators know that the furnace works sharper and that like heats can be tapped in a shorter time, as recorded from charge to tap, if the checker temperature is high. Obviously, more production can then be obtained from the furnace. However these temperatures must be limited or the brickwork will be melted down. Limits can be maintained with reasonable ease where the furnace operator uses properly installed and properly maintained radiation equipment. In so doing production is increased, valuable refractories are conserved and costs are lowered.

Total-radiation equipment as used to indicate blast furnace stove dome temperatures accomplishes almost the same things that is accomplished when like equipment is used on open-hearth checker chambers. The checker brick in the stove can be heated to a desired high temperature without the danger of over-heating the brickwork. Thus, higher blast temperatures can be maintained for given stove capacities while protection against overheated stoves is enjoyed.

There are many applications outside the steel industry where this type of equipment is used to advantage and still others where the equipment can be used and has not been given a trial.

It will be to the advantage of anyone connected with processes involving temperatures of 1800°F and higher to investigate the possibilities of this type of equipment.

Quick Installation of Tube Thermocouples in Cracking Still

By WINFIELD T. D. BROCK
Instrument Engineer
The M. W. Kellogg Co.
New York City

TUBE "skin" temperatures are used to good advantage in exposing "hot spots" due to improperly adjusted furnace fires. With an intelligent analysis of skin temperature readings an uneven distribution of furnace heat can be quickly detected, and the "coking off" of tubes can be accurately determined in time to prevent tube rupture.

A quick and inexpensive method of attaching a thermocouple to the exposed side of a tube in a cracking still furnace is the use of one continuous length of No. 14 gage duplex Chromel-Alumel asbestos-covered thermocouple wire between the hot junction of the furnace tube and the thermocouple switchboard panel.

The location of the couple is marked off on the fire side of the tube and the scale removed with a ball peen hammer. Two holes, barely large enough to insert the thermocouple wires, are drilled ½" apart and ⅛" in depth. The portion of wire exposed in the furnace is additionally protected by encasing it in woven asbestos tubing. Then the permanent asbestos covering on the thermocouple wires is skinned back ⅛" and the bare wire thoroughly cleaned with No. 00 emery cloth. The clean thermocouple wires are inserted in the drilled holes up to the asbestos insulation (so that no bare wire is exposed), and then bonded by peening the tube around the wire with a blunt center punch. This has the effect of pushing the metal of the tube against the thermocouple wire and forms a tight, metal to metal bond. The woven asbestos tubing is slipped up flush to the hot junction and a small amount of furnace refractory cement is placed over the asbestos tubing at the hot junction so as to exclude furnace gases. The asbestos wire is then brought through the furnace wall or drawn through openings between the tube headers and from there it is protected by conduit to the thermocouple switchboard panel.

This method eliminates stringing porcelain beads on the thermocouple wires, usually four to eight feet long, and the installation and welding of stainless steel protective tubing to the furnace tubes.

Mechanization of Bulk Density Test

By GEORGE BOTTUM
Chief Chemist
The Andrew Jergens Company
Cincinnati, Ohio

MEASUREMENT of bulk densities, using the hand-tapping method, is a time-consuming and tedious operation. It is also open to error, especially that old bugaboo, the "human element," even when carefully done.

Bulk density tests are important. They make possible an accurate estimate of the degree of packing that may be expected in transit and on store shelves, thus avoiding any unpleasantness with the Food and Drug Administration because of a deceptive container or partial fill.

We have constructed a machine somewhat similar to the one described by Becker *(Farben Zeitung*, Vol. 38, 1933, page 1685). The apparatus consists of graduated cylinders supported by clamps and riding on a cam, which causes it to rise and fall. The distance of fall is 1⅛". The number of strokes is 120 per minute. We use a small electric motor with a reduction gear to arrive at the 120-r.p.m. shaft speed. The cylinders fall on a rubber mat, the resiliency of which helps pack the powder, as well as cuts down the breakage of the glass cylinders.

With a running time of five minutes the powders tested reach a minimum volume for this distance of fall. When this point is reached a longer running time does not appreciably decrease the volume.

This apparatus has proved to be a real time-saver.

Versatile Automatic Gaging Fixtures Are Needed

By C. C. STREET
Engineer
Sperry Gyroscope Co., Inc.
Garden City, N. Y.

DESIGNING gaging fixtures for mass production inspection has always presented difficult problems in the use and application of standard indicating means. These problems are caused by space limitations due to the physical size of such standard equipment and the demand that the face of the instrument must be visible to the inspector. The result is that only a few of the measurements desired may be taken in one fixture and these usually by the means of complicated mechanical levers and motion transferring mechanisms. If high magnification is desired, the forces necessary to operate the indicating device is usually inordinately high, and the lag in indication is large.

Modern developments in electronics have been such that practically all of these difficulties can be eliminated. Proper design of such a measuring unit would produce a small cartridge, perhaps ¾" diameter and 1" long, with a contact at one end and a small light wire from the other. These cartridges could be placed in a fixture or machine as desired and as many as wished used with a single indicator. Almost any combination of indicator, signal light, or limit control might be incorporated, and selected at will by a step switch. Magnification could be greater than any instrument now in standard use, and with the use of existing technique, remain unaffected by line surges and voltage variations.

With the present demand for efficient mass production, it seems deplorable that our own inertia should cause us t

disregard, in a field so important, the fruits of modern technical development.

[EDITOR'S NOTE—Multi-point gaging fixtures employing small electric "ultra-micrometer" units were developed eight or ten years ago, have been commercially available for about two years, are being successfully used in Army Ordnance Arsenals and no doubt also in civilian-owned industries. See *Instruments*, Oct. 1940, page 291. Mr. Street, however, evidently proposes automatic measuring fixtures embodying simpler as well as smaller indicating units.]

Continuous Electrical Gages for Sheet and Strip Materials

By FRANCIS BUCKINGHAM
Vice President
Magnetic Gauge Company
Akron, Ohio

CONTINUOUS gaging of thin sheet or strip materials in production or on an inspection line is increasing rapidly. It may be of interest to briefly explain some typical applications.

In the steel industry cold mills are today running up to 4000 ft. per minute only because they are equipped with continuously indicating gages from the readings of which the roller can adjust his roll settings to keep the thickness uniform. This uniformity of thickness in auto and airplane body sheets insures accurate forming in the press, increased die life and may prevent die breakage. Here we have rolling speeds ten times faster than when hand micrometers were used, the dangers of hand "miking" are eliminated and greatly increased uniformity is attained.

The above comments are also true for tin plate which is now rolled in large coils. These long coils are generally sheared into short flat sheets on a flying shear line. In this case a continuous gage is used beyond the roller leveller and the indicating meter has built into it control features which cause a gate, beyond the shear, to open and discharge from the line of sheared sheets all those which are too thick or too thin.

Razor blades, accurate clock springs, resistance wire of high uniformity, flat copper wire for armature winding, flat steel wire for flexible conduit manufacture are other typical examples of continuously gaged metals, both ferrous and non-ferrous.

The rubber industry has long used continuous gages on their rubber calendars where a thin uniform sheet is produced and immediately applied to fabric which is used for the various plies in auto tires. The paper, fabric and plastic industries are also using continuous gages during production and in some cases are automatically maintaining the thickness between desired limits.

Width gages are also available for use on narrow strip either by themselves or beside thickness gages in which case both width and thickness are continuously gaged.

Three types of instruments are available for use with continuous electrical gages, namely: (1) Indicating, (2) Indicating plus Recording, (3) Indicating plus Control. Using the (2) type you have a permanent record of variations and using the (3) type you are able to automatically stop and start machines, slow down or speed up, adjust roll settings of calendars, assort pieces of cut materials, flash lights, ring bells or otherwise control functions based on variations of thickness beyond pre-set limits.

Some outstanding advantages of using continuous gages are: (1) Total inspection, (2) Faster production, (3) Uniform accuracy, (4) Increased safety, (5) Economy of materials. All of these contribute to the War Effort today and will aid in producing better and cheaper sheet materials after the war is won.

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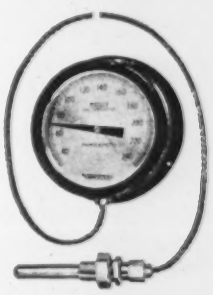

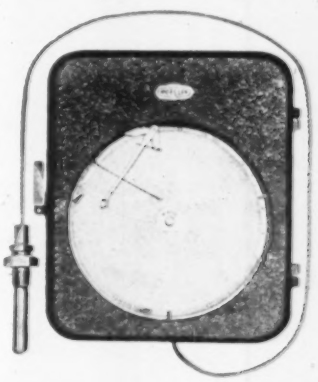

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4—WOMEN AND "MEN'S WORK" By Two Men

Women in Industry Aid America's War Effort

By JOSEPH MANUELE
Director of Quality Control
Westinghouse Electric & Mfg. Co.
East Pittsburgh, Pa.

PRECISION is the watchword of today's industry. Deft feminine hands, and the temperament that goes with them, are playing an important part in building precision into equipment that today is essential to America's security.

For example, nearly every Westinghouse plant employs women for jobs requiring dexterity with inspection instruments, delicate materials and minute parts. Women have been found to possess patience, and a willingness to perform repetitive tasks. Equipped with the proper instruments,

CLOSE-UP of a CLOSE LOOK at an instrument movement through a jeweler's loupe by an inspector at the Westinghouse Newark plant.

women make skilled inspection workers, especially if called upon to look for errors in production of small objects, such as parts of lamps, thermostats, instruments and meters.

Many sensitive electrical instruments, manufactured in the Newark, N. J., Westinghouse plant, are assembled by women. Wielding dainty tools somewhat resembling those on her dressing table at home, a feminine craftsman can quickly piece together an instrument mechanism out of little bits of wire and pieces of metal. Nimble-fingered women in the Westinghouse Mansfield, O., plant assemble 31 parts to make an electric thermostat control no larger than a half dollar. Women make lamp filaments, coils of wire as small as 0.009" in diameter, in the Company's lamp plant at Bloomfield, N. J. Others "mount" the filaments, using a pair of tweezers and diminutive welding machines. Even the giant waterwheel generators, manufactured in the East Pittsburgh Westinghouse plant, represent many hours of painstaking work by expert women coil winders.

The use of women is still in its early stages, but the possible future trends are now being charted by the women already employed in industry.

Entirely aside from any scarcity of man-power, women's fingers are more nimble, they work faster and generally possess a higher all-around "manipulative factor." Men soon get fed up on routine work, but women don't mind it. Not only do they seem to enjoy their new jobs and intricate work, but they also feel that they are doing their share to help their country. So electric appliances, plastics, radio tubes, motors, generators and many other Westinghouse products all incorporate important work done by women—work which they are able to do best because they are women.

New Girls' Quick Grasp Debunks Instrument-making "Gift"

Author's photograph not received as this issue goes to press

By W. A. REICHEL
Director of Engineering
Pioneer Instrument Division of Bend'x
Aviation Corp., Bendix, N. J.

NATIONAL Defense at first, and now War, put an entirely different aspect on the aircraft instrument industry. Aircraft instrument manufacturing became a production problem a couple of years ago. When the expansion of production was anticipated, it became evident that no instrument makers were available to do the job. We did not have time to train instrument makers—which usually takes a few years; we had to use girls to assemble and calibrate instruments.

We succeeded in doing this on a large scale, using girls who were stenographers, teachers, musicians, painters, etc. You can see them today assembling successfully the most complicated instruments, inspecting and testing them.

I do not fear going on record as making the emphatic statement that during the last year we took the halo away from the so-called "born" or "genuine" or "gifted" instrument-maker—the man who could make the instruments work and was the only one who could do it because he had this uncanny skill. Girls are doing it now—doing it *satisfactorily*.

We took the mystery out of instrument work and made it an every-day problem. In the future, this will affect tremendously the use of instruments in every-day life and will help us, after the war, to use the most complicated instruments and enjoy the comfort and assistance which precision devices can give us.

A WOMAN SPECTROGRAPHIC ANALYST, Mrs. Alice ("Pat") O'Hara, of G-E, was shown in action on our July 1941 cover and her story was printed on page 193.

"The province of industrial instrumentation is almost exclusively masculine. There is no compelling reason why it should remain so. It is an enormous province, made up of diversified fields. In particular, the use of industrial testing instruments is a field where women can render excellent services and find happy careers."—From editorial in July 1941 *Instruments*.

"The day is past when employers may compete with the Army for physically fit men. . . . Eventually the only labor supply may be women."—Lieut.-Col. Joseph F. Battley, quoted in the *Pittsburgh Press*.

. and Two Women, All Four In Position to Know

Women Metallographers

By Mrs. CONSTANCE B. BRODIE
Head, Metallographic Service Section
General Electric Research Laboratory
Schenectady, N. Y.

METALLOGRAPHY can be defined as a branch of metallurgy dealing with the study of the structure of the pure metals, the relations of the individual pure metals to one another, and the effects of manufacturing processes such as heat treatment, on these metals.

There probably are not more than fifteen women metallographers in the country. But the work is fascinating, particularly right now when the examination for defects in an insignificant-looking sample of metal may save a battleship turbine from destruction.

Girls planning careers would do well to investigate the possibilities of metallography. The requisites are a knowledge of physics, chemistry, physical chemistry and metallurgy, all of which can be obtained in most engineering colleges. Government-sponsored night courses which include these subjects are being conducted.

The work being done in the G-E Research Laboratory includes the constant development of new alloys to replace or improve those now being used, with the purpose of relieving the shortage of strategic materials. My work is almost entirely with the microscopic end of metallography. Samples of metals or alloys received for study may vary from less than the thickness of a hair to a piece cut from a giant turbine. We study new products of research as well as metals that have been in service. Samples are mounted in plastic, ground and polished to obtain a specular finish free from scratches, then etched (each with a suitable reagent) to obtain proper degree of contrast, studied under the microscope, and photographed at magnifications as high as 1500×. We have quite an array of metallographic instruments, as well as our own darkroom and equipment for developing, printing, enlarging and mounting.

As to my own "case study," I doubt its value to *Instruments* readers but here it is: I had never heard of metallography and just vaguely of metallurgy until I found myself in the midst of it. Having finished a dietetic course at Pratt Institute (Brooklyn, N. Y.) which included organic chemistry, bacteriology, and physiology, I was selected by the U. S. Steel Corp. Research Laboratory (Kearney, N. J.) to be trained as a metallographist, and switched to a similar job at G-E when I married a Schenectady man. The War Effort angle of my work is doubly interesting to me now: I have a brother somewhere on some ocean in the U. S. Navy.

Women Instrumenticians

By MARY E. WARGA
Director, Cooperative Spectroscopic Laboratory
University of Pittsburgh
Pittsburgh, Pa.

WITH the oft-repeated statement that this is a mechanical war and will be won primarily by production, it is not surprising that the subject of women instrumenticians should become important. Women in War Effort industries have come a long way from the ambulance drivers, assistants in routine chemical laboratories and others who were publicized during the last war. With the advent of the airplane, women are working not only on the assembly lines where their patience and thoroughness in detail makes them valuable, but also are taking part in designing and flying the planes even to test-piloting and ferrying bombers.

In the field of testing materials, women's work ranges from routine chemical or microscopic testing to the more complicated and exacting spectroscopic and x-ray methods of analysis.

In the fields of medicine and public health many highly-skilled women technicians are rendering valuable services.

In industrial and scientific research laboratories women are in many cases designing and building as well as using intricate and sensitive instruments.

And—"this is only the beginning" for women instrumenticians.

Courtesy *Pittsburgh Press* and University of Pittsburgh

What? Don't you two ladies know each other? Mrs. Brodie, meet Dr. Warga; Dr. Warga, meet Mrs. Brodie. Now may I present thousands of your fellow readers who are mere men?

5—REPORTS, RECOMMENDATIONS, Etc.

A Live Policy for an Instrument Department

By EARL C. RIEGER
Head, Instrument Division
Gas Power Engineering Department
International Harvester Co.
Chicago, Ill.

WHEREVER instruments have lost favor, almost invariably the cause may be traced to defective operation and usually due to neglect, or a laissez-faire policy of "fix-it-when-it-breaks-down." Each time this happens, the instrument readings are believed less and less until finally all are taken with a grain, or rather a cupful, of salt, or disregarded entirely.

If people doubt the accuracy of your instruments, you have two strikes on you at the start. Therefore, your slogan must be "Our Instruments Always Tell the Truth." Now you've said something. Can you make it stick? The answer is to so carefully plan your checking and calibration schedules and methods that the faulty or defective instrument operation will be virtually found before it occurs. Proper application is of course fundamental to satisfactory results.

With such a goal, one can realize the importance, yes the priceless value, of a really well organized and efficient instrument department. The answer is not simply acquiring a room, cupboards, shelves, and a lot of fine instruments. That is only a beginning. The complete picture includes careful selection of men, a program of training for the particular field involved, and a real sales story to your "customers" backed up by the ability to produce.

This is the ideal setup, as I see it. To achieve this 100% is Utopia. However, we must have a goal.

Adopting Quality-test Noise Meter Brings Amazing Results

By J. A. ROBERTSON
Chief Design Engineer
Warren Telechron Company
Ashland, Mass.

WE are all amazed, even today, by the unforeseen benefits that are realized when instruments are applied to control some value previously dependent upon the operator's judgment. A case in point is the inspection of Telechron synchronous electric clock motors for quietness.

When only the human ear was used as the gage, rejections were almost constant regardless of the vagaries of production. Some time ago, sound measuring instruments were applied to this test and it was then found, as anticipated, that rejections above a selected standard varied considerably from one time to another. Analysis of the causes of high rejections led to a general improvement of quality so that eventually it was possible to substantially lower the acceptance standard.

But most surprising was the fact that with the variables under better control, slight deterioration of the quality in a *single* part could often be recognized and located by the operators using the sound level meters before the motor noise had been appreciably affected. In this way, wear or dulling of a tool was frequently located and corrected *before* it had advanced to the degree where it would have been detected by normal inspection processes. Thus, the use of the noise measuring instruments has led to a better control of the quality of parts than was possible by any reasonable inspection of the individual parts themselves.

Lithographic Industry Becomes Instrument-conscious

By WILLIAM H. WOOD
Director of Chemical Research
Harris Seybold Potter Company
Cleveland, Ohio

ALTHOUGH operating as a craft for generations, the lithographic printing industry is today becoming instrument conscious and is fast approaching the status of an exact and controlled scientific process. The lithographic process is a chemical process and light-sensitive coatings, plate-dampening solutions, inks and the like are tested for viscosity, density, acidity or alkalinity, color quality and other chemical and physical characteristics, both by the manufacturers of such products and by large-scale users. We, as world leaders in this field, also use resistance thermometers and temperature control devices, in manufacturing synthetic compounds to replace such products as egg albumen and natural gums which have been, for the last seventy-five years, required essentials for the process. These new products overcome many difficulties encountered when the naturally occurring products are employed. Looking forward, we may be sure that precision instruments will find an ever-widening market in our industry.

"Reading Eyes" for the Blind

By JOHN M. WHITMORE
Head of Elec. and Vibration Div. of Experimental Dept., Allison Div., General Motors
Indianapolis, Ind.

AT a time when most thought is directed toward means of destruction it is relaxing to think of means for helping our less fortunate blind friends. Though much money and time have been spent toward furthering the education of the blind, it still is very limited. The two most used methods by which blind persons gain information, other than by conversation, are by books printed in Braille and phonograph recordings. Both of these methods are limited and expensive. It is quite possible that a printed page might be transformed into intelligence by means of sounds or raised letters.

If a viewing screen, the height of the letters and about one fifth as wide, progressed across the printed page it would have dark and light sections according to the letter viewed. Now if this viewing screen contained about five or six section, which when illuminated, produced audible sounds of different frequencies, with practice it might be possible to recognize the letters viewed.

If each of these sections of the viewing screen controlled a plunger in a flat plate it would be possible to raise the portions of the letters covered. In this way a person would be able to feel the letter, very much as though he were passing his finger over raised letters. This latter method probably would be more readily learned but it is likely that the sound method would prove more rapid after once mastered. Either of these methods would employ photocell control.

From One Who Serves Utility's Customers in Mountains

By HAMMOND MATHEWS
District Superintendent
The Western Colorado Power Company
Silverton, Colo.

SOME of us in the isolated sections of the U.S.A. know *Instruments*, the magazine that tells about instruments and is doing a wonderful job. We study this journal a great deal, and as some of us connected with the mining industry have problems which we believe are somewhat unusual we look in *Instruments* for the new developments which will fit the rigors of continuous operations, weather plus adverse operating conditions, and locations both outside and underground up to 13,000 and more feet above sea level. I believe that the manufacturers can well use *Instruments* to bring to the attention of some five thousand operating mines and mills, metal mining operations alone, in the U.S.A., a great deal more instrument information, as well as news of instruments better adapted for mining and milling uses than are now to be had. The market for instruments for use about mines, mills, and associated operations is as yet untouched. From the operator's end, he can use many instruments that will pay for themselves in a matter of months, perhaps weeks, through knowing by visual indications or graphic records what pumps, crushers, flotation, mills, conveyors and other units of production are taking in power alone. The field is unlimited. This is based upon operations of several mining properties which have operated continuously through the years.

Cites Hospitals as Automatization's Beneficiaries

By JAMES F. MAHER
Engineer
Winslow Indian Sanatorium
Winslow, Ariz.

THE demand of production and the many-fold increase in the rate of production, with the general speeding up and action demanded of all industry, brings forth the need of wider use and coverage of instrumentation.

This rush will greatly benefit the engineers and production men, for by the time the war is over and the demand for hurried production slackens, "the powers that be" will have learned the important part correct instrumentation plays, and will encourage the purchase and use of more instruments, instead of "a little later" or "we'll see about it"; thereby making it possible for the engineer to bring forth efficiency at its best, and enabling him to show the boss just how a change here or an addition there will improve operation and cut cost. When war demand is ended,

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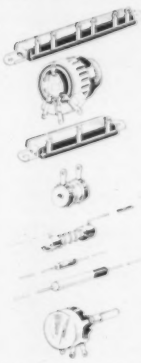

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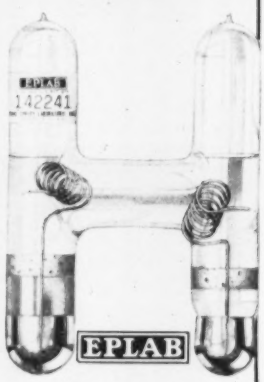

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NEWPORT RHODE ISLAND

cost is going to play a major part in the engineer's headaches, and the wide use of instruments is going to be his panacea.

Automatic control relieves men of jobs that just demand attention, and thereby frees men for more pressing parts in this war. In hospitals alone (though everyone's prayer is that there will be no rush in them) instrumentation plays a vital role. Sterilizing steam pressure must be up and constant, operating equipment must be at highest efficiency and on call at all times, X-ray equipment and procedure must be correctly controlled, all of which, and more, goes back through the many and varied controls and instruments needed, to the power generating and distribution equipment, and the boilers with their oft-needed and necessary controls and operating devices. The result of which brings comfort and painless attention to the injured, and their confidence in the doctors and nurses.

Truly, the increase in efficiency in all industries and professions, gained at this time in a relatively short period, will not have been exceeded beforehand.

Engineering Educator Discusses Three New Trends

By A. V. deFOREST
Professor, Dep't of Mech. Engineering
Massachusetts Institute of Technology
Cambridge, Mass.

I—AUTOMATIC CONTROL

A CONTROL instrument may be regarded as one which not only measures or records some such condition as temperature or pressure but also automatically performs a further step of interpreting the measurement into a useful action as, for instance, the pyrometer which turns off the furnace when the proper temperature is reached and turns it on again as the temperature falls. In many cases this is a simple procedure but in others not only a condition is to be measured but the rate of change of this condition.

Measurements of rates of change are already well known in certain fields. Inertia-type governors are perhaps the oldest but rate of change of temperature by using the differential between two thermocouples, one imbedded in a large mass constituting a heat reservoir and the other measuring the actual temperature of the material, is only fifty years old. Similar expedients can undoubtedly be used for other processing conditions.

In many cases of complicated industrial controls a number of factors must be taken in conjunction with one another to initiate the proper control mechanisms and much future development in the instrumental field remains to be done along these lines. Perhaps even such complex operations as the control of an open-hearth furnace may some day become fully automatic when automatically repeated spectroscopic analyses direct the addition of alloying agents and each heat of steel is tapped at exactly the right instant!

II—STRAIN GAGES

STRAIN gages are now so cheap that they may be discarded after a test, so light that thousands may be left in place on airplane structures for use at any time, so versatile that they may be used in any gage length on curved or flat surfaces, so gentle that they may be applied to metals a few thousands thick, so responsive that they have no limitations as to speed of load and so new as to have unlimited possibilities! Such, gentlemen, are the resistance wire gages known as SR-4's. A host of new measuring and recording instruments, from simple d-c. bridges to cathode-ray oscillographs and amplifiers with frequency response in the megacycles are in process of development. Every strain problem from magnetostriction to armor plate

may now be reduced to an essentially simple resistance measurement. No wonder close to 100,000 resistance-wire gages have been used in the past year, and that as a direct consequence, the development of American airplanes is progressing rapidly due to better instrumentation.

III—INTERPRETATION OF MEASUREMENTS

INSTRUMENTS may measure, but human beings interpret, and in far too many cases the interpretation is faulty. For instance, because the hardness testing of metals is well instrumented, a numerical value for some type of hardness is frequently used in specifications. Sometimes the useful behavior of the metal may be measured in terms of hardness, but sometimes not, and all too frequently the paper-pushing specification writer does not know what combination of mechanical properties are implied by his figure of hardness. High hardness is needed in a cutting tool, but in itself is not a sufficient specification, as shown by many types of stainless cutlery steel, of sufficient hardness, but without the ability to hold a cutting edge.

Because soft material may sometimes be easier to machine than hard, much confusion has resulted when softer metals are specified with the expectation of curing a troublesome shop problem. Frequently harder rather than softer metal is the proper answer. In other words, instruments are immeasurably valuable to men of skill and judgment, but likewise they may lead astray those of dangerously little knowledge, by furnishing an accurate measurement of the wrong property.

A Plan for Planning What to Do First

By GEORGE L. SEAVEY
Instrument Engineer
Eastern Gas & Fuel Associates
Boston, Mass.

HAS it not occurred to you that as an instrument man your most frequent decision is where to put the emphasis when planning work? Perhaps you have a meter to replace and a part to make or buy and several other jobs to be handled as soon as possible. A decision must be made as to relative importance or order of precedence.

An engineering mind prefers to make these differentiations on a better basis than pure supposition, because without the facts an improper conclusion can be expensive, a nuisance and inefficient.

Submitted below is a suggested angle of attack which can be changed to suit any particular case.

Instr. Name Inventory No. Serial No.	Cost	Present Service: Prod'n	Present Service: Inform'n	Degree Maintenance	Available Service	Substitution	Merit Factor

The object of the table is to intelligently be able to assign a merit factor to each instrument and finally select the order of precedence. The number of determining factors can be added or subtracted. Cost alone (though not usually) may be a basis.

In any event the authority of needs, operator's viewpoint, maintenance department capacity and emergency flexibility from a practical viewpoint will specify the designation.

Such problems as which instrument gets first attention, and by what kind of an instrument man, can be readily answered. Installation engineers should find this sort of assistance valuable.

A similar analysis might answer the often-heard question: shall I make it or put in a requisition?

This idea may be carried into other fields than instrumentation. It applies to control laboratory work where certain analyses come essentially before others.

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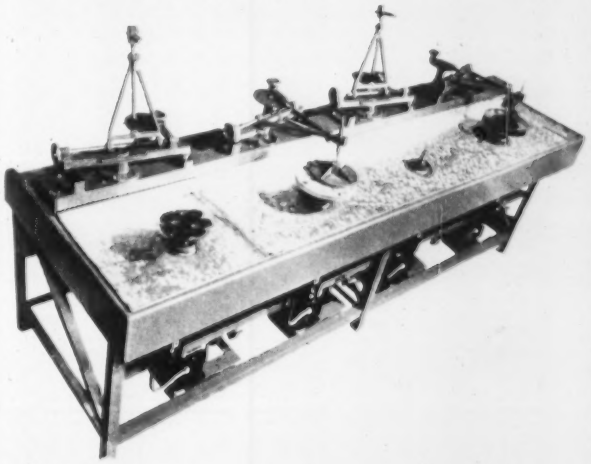

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6—SPECIFIC PREDICTIONS

Extensive Use of Radio Circuit Instruments Foreseen

By HARRY A. EHLE
Assistant to the President
International Resistance Co.
Philadelphia, Pa.

IN 1933 our company, which had previously concentrated on the commercial radio industry, established an Industrial Division to follow up the use of the vacuum tube in applications other than commercial receivers.

Eight years of watching this market develop and expand has proven to us that the use of electronic devices and their associated apparatus is still in its infancy and that its potentialities are great.

We are willing to predict that out of the present conflict one of the effects on our industrial life will be the tremendous acceleration of the use of vacuum tubes in electrical circuits. Hundreds of ideas for commercial applications are developing as a result of the electronic developments under way for War Effort uses. These will by no means be forgotten and will, in some instances, revolutionize established techniques when the opportunity arrives for adapting them to peace-time needs.

Many old industries using electrical devices, through inertia or distrust, have rejected "radio" type circuits and we venture to suggest that they will be forced to modify their views by the mass of evidence available.

We have already seen a major change in the numbers and types of electrically operated instruments available during the past five years. We should prepare, by investigation, by research and by training, our organizations to use these new electronic tools to the best of their advantage.

Radio Circuit Instruments Will Solve Industry's Post-war Problems

By GEORGE A. F. MACHLET
[res.] 1016 Lafayette St.
Elizabeth, N. J.

INSTRUMENT and control manufacturers are today faced with two major challenges. The first of these involves the immediate adaptation of various control systems to military uses on a vastly expanded scale, while the second involves the simplification and improvement of such systems to assure a market after the war.

Interest in electronic control systems has steadily increased in the past few years not only because of the sensitive response of which they are capable, but because of the latitude they allow the designer and engineer to adapt them to innumerable uses. Simplicity, compactness and light weight adapt them to the control of variables even on aircraft, thereby contributing toward greater efficiency. Flexibility in design permits the integration of two or more variables as well as isochronous regulation of a condition by the simplest troublefree means. They should therefore find application in the field of fire control apparatus, directional control of vessels and other military problems.

After the present emergency the industry will inevitably be forced to compete with the "used instrument market" but will be in a position to cope with the situation by manufacturing a better product at considerably lower cost. This will be possible not only because of the ease with which electronic control systems can be manufactured on a mass production basis from standard parts, but because of wartime experience in applying them to many new uses.

Instruments and the Progress of Aviation

By CHARLES I. STANTON
Acting Administrator of Civil Aeronautics
Civil Aeronautics Administration
Washington, D. C.

ON Christmas Day, 1941, a flying boat bearing urgent dispatches arrived in Canada after a 23-hour flight across the Atlantic, the first 18 hours of which were flown at less than 500 feet over the sea, because of dangerous icing conditions at higher altitude.

This trip is merely a dramatic example of flights which are made every day, thanks to aircraft instrumentation. Without such instrumentation, flying would be confined to days of excellent visibility, and its usefulness in peace and war would be cut at least in half.

The continued growth of aviation calls for the development of instruments to the point where flying is made virtually immune to interruptions because of weather conditions.

The Civil Aeronautics Administration, in coöperation with the aviation industry and the armed forces, is working hard on the problems that this involves. Every step forward in the field of instruments will be a real contribution to the War Effort and to the permanent advancement of aviation

Radical Improvements in Aircraft Instruments and Controls Foreseen

By R. D. KELLY
Superintendent of Development
United Air Lines Transport Corp.
Chicago, Illinois

NO other means of transportation depends so entirely upon instrumentation for its success as does air transportation. Without adequate instrumentation the Flight Crews would be unable, under many circumstances, to determine the location, direction, speed, altitude, and attitude of their craft, or make any measurement of the power plant conditions.

However, we are just now seeing the beginning of instrumentation and automatic control in our industry. There is no doubt that it soon will be possible for a Flight Crew to pilot an aircraft from one airport to another hundreds of miles away without having any visual contact with the ground throughout the entire flight, including both the take-off and the landing. The next step beyond that attainment will certainly be absolutely automatic flight whereby the Flight Crew will only need to adjust and check the functioning of the automatic flight equipment.

The fundamental aircraft instruments now generally in use, such as the Airspeed Indicator, Altimeter, engine in-

struments and the gyroscopic flight instruments, have seen no great improvement during the past several years. It is time for some radical improvements. For instance, the present Artificial Horizon and the Directional Gyro (or the Automatic Pilot) can be upset in violently rough air. Under such circumstances the pilot loses his major attitude and direction references. He must then resort to the turn indicator to regain control of his craft. This is admittedly a difficult task and may easily result in confusion at a time when every second counts. Some absolutely infallible attitude and direction reference would be a most important development. Almost every instrument function can be improved or a more efficient substitute developed. They all deserve attention.

More effort should be expended to produce light-weight rugged (crash-proof and fire-proof) recorders which will provide a permanent record of conditions existing during flight. This record is needed for routine analysis of operations and will also be valuable in any non-routine procedure or accident. The functions which should be recorded are many. Altitude, airspeed, outside air temperature, humidity, power and power plant conditions, and accelerations, could all be utilized to advantage in present operations. A record of the direction of the aircraft throughout its flight would be of value also.

Aircraft instrumentation is considerably different from instrumentation as applied to most industrial operations and processes. However, the basic principles are the same. It is hoped that more instrument manufacturers will give attention to the possibilities and needs of air transportation.

Six Probable Trends in Design of Instrumentation Products

Author's photograph not received as this issue goes to press

By HERBERT ZIEBOLZ
Vice President
Askania Regulator Company
Chicago, Illinois

IT is my belief that the instrument and control industry is still in its infancy and that the development of the next decades will follow lines which are at present shown in the aviation industry where safety factors and available space restrictions have made an accelerated development imperative. This means:

(1) Standardization of instrument dimensions, making it possible to interchange different manufacturers' instruments with one another using the same mounting holes. This will make it possible also to modernize installations without rebuilding panels.

(2) Multiple recorders—probably of the electrical repeater type—will tend to replace individual instruments with corresponding savings in service, charts and space.

(3) Repeaters (preferably electrical) will be installed at strategic points with additional, mechanical gages (Bourdon tubes, U gages, mercury thermometers) as second lines of defense.

(4) Controls will be standardized, providing mounting brackets of identical dimensions for power units of various manufacturers.

(5) There will be—by force of circumstances—a wider cross-licensing of instrument and control manufacturers in the interest of the most important factor in this field; the consumer.

(6) There will be a definite trend of standardization of instrument and control circuits and arrangements for certain standard applications. For instance, this will enable any furnace operator after a few instructions to be at home on another furnace. (Airplane pilots justly insisted on such a uniform arrangement, to the advantage of everybody concerned.)

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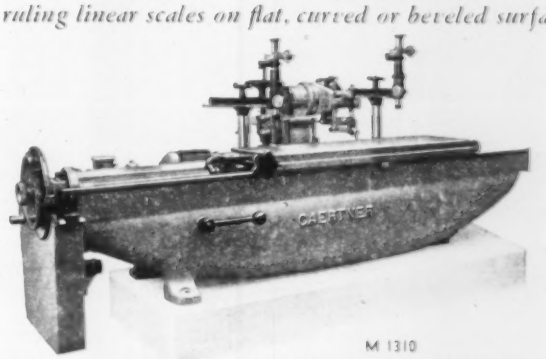

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Extensive Use of New "X-Y" Recorders Foreseen

By GEORGE KEINATH
Consulting Engineer
Instruments, Measurements, Testing
Larchmont, N. Y.

IN general, it seems to me that as a consequence of the perfection of amplifiers and rectifiers the tendency in instrumentation is toward increased application of alternating current for all measuring, controlling and testing problems. A.c. eliminates many of the troubles we encounter with d.c., especially leakage and corrosion.

I see great possibilities in applying modern instruments and especially high-speed recorders for "100% Production Tests" in all kinds of industry, especially War Effort Industry, in order to eliminate all failures due to untrained and inexperienced inspection personnel. Such automatic records give a clear and unbiased picture of the quality and uniformity of production in much less time than required by spot readings. Wherever tried, experience has shown that only a test which results in a diagram really can tell what has happened during the test.

The development of "Coördinatographs" (or, as I would rather call them: *X-Y* Recorders), suggested in the *Instruments* editorial of May 1940 by Major M. F. Behar, is highly desirable. Such recorders which, as defined there, "plot automatically the mutual values of two measurables, neither of which is time," may trace diagrams in less than a minute, replacing from 50 to 100 spot readings of one or two observers which cannot be made in less than five or ten minutes. The cathode-ray oscillograph is the most prominent of such *X-Y* recorders and its application in production testing is rapidly increasing. It generally lacks, however, the permanent diagram—which I consider essential for comparison—and it can only be used for a limited number of testing problems.

I am sure that within a few years "Test Recorders" will find their way and will either improve quality and safety or they will reduce the cost or the weight of the products with the present factor of safety.

Re Future of Flowmeter Types: "Float" Will Rise and "Head" Will Drop

By KERMIT FISCHER
Technical Director
Fischer & Porter Company
Hatboro, Pa.

SOMETIMES prophecy is easy despite the many adages urging that prophecy be shunned. In the case of flowrate measuring instruments the present war requirements for solution of unusual problems seem to point out unmistakably the path future development will take. An almost universal use for these problems of variable-area type flowrate meters, in some cases of standard design, in other cases of radically new design and appearance, is typified by the thousands of variable-area flowrate meters being supplied for measurement of oxygen feed to aircraft personnel and fuel feed to aircraft motors.

Already at least eight instrument manufacturers are in production in the United States on a widely diversified array of variable-area flowrate meters. Because many of these meters are being used for specific specialized services not of immediate general industrial interest the engineering profession as a whole is only vaguely aware of their numerical prominence.

Accuracies of 99.75% over flow ranges as great as 20:1, immunity of calibration to fluid density changes of over 10%, freedom from effect of viscosity changes as great as 10:1, the compactness and lightness of the smallest standard aircraft instruments, and inclusion of complete pneumatic automatic control, are among features incorporated in some of the more recently developed variable-area flowrate meters together with design simplicity apparently unattainable in head type (orifice) meters. Many ingenious devices such as the "fluted tube" variable-area flowrate meter have solved problems such as the vibrational one.

Wherefore this prediction: By the end of the war and the resumption of normal technologic development in industry the engineering profession's conception of what constitutes a satisfactory flowrate meter will have been substantially altered. This will refer particularly to simplicity of basic design, simplicity of installation and freedom from effects of operational and fluid characteristic variations. This advance in viewpoint will be accompanied by an ever-accelerating acceptance of the flowrate meters relying on a varying area metering tube and a measuring bobbin, with rapid increase in the number of different designs and types offered commercially. Concurrently, reliance on the head type meter, consisting of straight length of pipe, pressure-differential-producing restriction and liquid-filled manometer, will rapidly diminish and almost disappear.

Electrical Instruments Yesterday, Today and Tomorrow

By CLARKE E. FRY
Foreman, Instrument Laboratory & Shop
Westinghouse Electric & Mfg. Co.
East Pittsburgh, Pa.

NOT so many years ago, control panels or switchboards had only sufficient instruments to indicate the voltage, amperes and watts; plus improvised devices for synchronizing generators, and only fuses as a protection in power lines.

Present-day rates of power consumption demand the use of such indicating instruments as voltmeters, ammeters and wattmeters for power calculations; frequency meters (indispensable since electric time clocks are operated on constant voltage and frequency); phase meters for checking instrument and relay connections; and synchroscopes for indicating the differential speed of two machines about to be paralleled on the same line.

The modern protective device is a specialized relay to prevent expensive electrical equipment suffering serious damage; it insures continuity of service by automatically disconnecting faulted line sections. With present-day activity the importance of relay protection against expensive shutdowns and serious interruptions to production cannot be over-emphasized.

Thirty years ago it was not a serious problem to shut down major portions of a manufacturing plant for repairs to electrical equipment and there was little need for relay protection to insure continuous service and speed of production. Abnormal conditions in electrical circuits then did cause frequent shutdowns of electrical equipment.

Today, with mass production, the instruments and protective relays play a most important part. Today as never before, electrical measuring devices, instruments and relays are being used to indicate, record and control power in industrial and utility companies' power plants; to conduct tests in the design of new electrical apparatus; and for functions too numerous to list. Tomorrow an even greater proportion of their functions will be accomplished automatically.

No Major Changes in Instruments for Months

By M. J. ZUCROW
President and Chief Engineer
Ring Balance Instrument Company
Chicago, Ill.

AMERICA has one basic program, the successful prosecution of the war on the Axis powers. Everything else must be subordinated to this, since upon its success our national and individual destinies depend. Victory can be purchased only through blood and tears . . . and sweat. Such is the background for the immediate future.

This country is about to make a war materials production effort so vast that it staggers the imagination. Unprecedented demands are made upon the metallurgical, mining, chemical, oil, paper, rubber, power and other basic industries. To meet these demands the non-military uses of all products are being drastically curtailed and additional production capacity is being constructed.

An increased immediate demand for industrial instruments and control apparatus is to be expected and for the next few months production will be the keynote. This will tend to exercise a restraining influence upon making major changes in instrument construction. An increase in the substitution of more readily available materials for those on the critical list is, however, to be expected. In addition, the impetus to eliminate or reduce the amount of mercury required to operate certain of these instruments will undoubtedly stimulate some interesting developments.

The instrument industry will have to forget "business as usual" and make its sacrifices and adjustments. For only as long as it functions as an integral and essential part of the Arsenal of the United Nations will it be serving America.

Needs and Trends of Chemical Industry Instrumentation

By HENRY S. WINNICKI
Chemical Engineer
Westvaco Chlorine Products Corporation
South Charleston, West Virginia

INSTRUMENTATION must play an increasingly important role in the chemical industry—particularly in the next few years. Plant capacities must be expanded and new processes must be developed. This will require a large amount of equipment fabricated of materials acutely needed elsewhere. Equipment requirements, in many cases, can be decreased substantially by making use of continuous processes. However, the inherent characteristic of a continuous process, small capacity, is so frequently accompanied by control difficulties which can only be met by specific instruments and controllers. Knowledge of the application of instruments and controllers will become increasingly important. It might well be said that design philosophy will be: "Design the equipment around the instruments and controllers."

In the field of new process development, technicians who are so seriously needed in vital defense work must become cognizant to the fullest extent of the work that modern instruments and controllers are capable of doing, in order that they may be released for other work.

A point that should be emphasized is that we have the instruments but need to know them much better than we do.

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7—EDUCATION AND TRAINING

High-school System Fails to Train Youths for Industry

Author's photograph not received as this issue goes to press

By RALPH D. WEBB
Head of Instrument Department
Carbide and Carbon Chemicals Corp.
South Charleston, W. Va.

SECURING good material with which to make instrument mechanics has proven one of the hardest problems we have. Company policy prohibits our employing technical graduates for other than technical work; consequently, we must rely on the output of our high schools. After having examined some three or four hundred applicants in the last five years, I feel quite definitely that our public school system is muddling its job of preparing students for the business of making a living, particularly in respect to their teaching Physics. The local educators, at least, seem to regard this subject as purely a college preparatory course, never realizing that the boy who must ultimately make his living with his hands will in all probability be employing The Laws of Physics 99% of his working life. Apparently, students given shop courses in high school are not permitted to take Physics when common sense tells us that they, of all persons, should be the ones to study it. Possibly some good might be done if each of us avails himself of every possible opportunity to explain what is meant by "Physics" to everyone interested in this subject, and, particularly, to those who are engaged in secondary education.

Instrument Engineers Who Know Processes Are Needed

By V. R. CHADBOURNE
Power Engineer
Magnolia Petroleum Co.
Beaumont, Tex.

THE oil refining industry may be expected to use more instrumentation, as well as much more complex and intricate mechanisms. The tremendous throughputs, together with the delicate refinements between products, means that with each forward step in the mind of the process engineer, the instrument engineers must devise measuring devices and controls which are reliable and sturdy, yet capable of delicate measurements. They may control not only individual flows or temperatures but may actually, as in some of the latest units, automatically direct and supervise a whole process.

This advance, technically, both in the process and its controlling accessories, means that the technical schools must be prepared to produce instrument engineers schooled not only in the theory of instrumentation, but also in the processes that their instruments control, otherwise, they would be blindly striving for results.

Conversely, it seems to me that those future chemists or chemical engineers, who would make the oil refinery industry their livelihood, should be thoroughly educated in the theory of instrumentation so that when they take their place in this industry, they may then more readily understand the capabilities and limitations of instruments in relation to the processes that they will attempt to command.

Plea for Maintenance of Training Standards

By RAY STEPHAN
Instructor, Instruments
Boeing School of Aeronautics
Oakland, Calif.

THERE has always been a shortage of *effective* instrument mechanics satisfactory for aircraft instrument work. Now this shortage has become an acute problem.

We are all of us doing our best to further the War Effort. For one employed in the training of aircraft instrument technicians this means an all-out effort and a nearly complete disregard for lofty Standards. If we can instill quality, well and good, but we MUST have quantity.

But what of the future? Quantity *minus* quality?

My personal opinion is that a reasonable compromise must be maintained by those responsible for training. Unless this is done our present high level of working man and working conditions in the aircraft instrument field must surely suffer a set-back. We must strive to continue to train instrumenticians and not merely instrument workers. Training people to think and act like a machine may be a sad necessity at a time like this but on a long term basis people so trained will end up as dissatisfied and unhappy workers. We should continue to train these persons, whenever possible, along the lines of "good wanting" and "good thinking" as well as for "efficient doing." This is not a plea for Utopia. It is merely a call for refraining from throwing everything overboard, thinking ahead a few years, helping many of these new recruits not only to get ahead but to stay ahead.

Our job in training instrumenticians for work in the aircraft field is a vital one. If well done, after this present crisis is over, we shall have the satisfaction of seeing this aircraft branch of instrumentation stabilized on better ground and with a view to new horizons.

Instrument Courses Mark Coming of New Era

By R. C. KENNAN
Manager of Service Division
The Brown Instrument Company
Philadelphia, Pa.

IT appears that the tremendous increase in production to meet our war effort needs has created an unprecedented interest in Industrial Instrumentation on the part of management, engineers and workers alike. On all sides there is a demand for more information and better information of the kind that only comes with experience in teaching it to others.

A Real Need for Engineers. There has been considerable thought and discussion among educators as to the merit of injecting a course on industrial instruments into an already overcrowded curriculum of engineering subjects. I would like to suggest that educators who are skeptical of the merits of such a move visit any of our large industries to see the importance attached to Instrumentation. One day spent with the men on the producing end would be ample

proof that there is a real need for engineers to know something about instruments before they enter today's work-a-day world.

Text-books and Literature. I believe that some of our progressive educators have already looked into the instrument field and are preparing to present the subject in some limited form. The few text-books available are well written and adaptable to student presentation. To supplement this, instrument manufacturers have a number of well-written publications based on years of practical application which they are generally glad to send upon request. There should be no hesitancy on the part of educators to launch into the subject on this account.

U. S. Government Training. One of the most encouraging trends is the practical approach to this subject by the large number of Instrument Maintenance and Repair classes conducted by the National Defense Training Program. Most of these classes are being taught by men who have many years of practical background. They are imparting much worth-while information to process men in all phases of production. There is no doubt that this work of educating the practical man will have a far-reaching effect in proving conclusively that instruments are a necessary part of the process and are here to stay. When these men understand their instruments and automatic controls they take a real interest in turning out a "bang-up" job and we can look forward to their many contributions to application of these devices.

A Challenge. It will be up to industrial engineers and management to keep abreast of new developments in the instrument field. The only way is by education.

War-time Advertising Should Be Instructive

Author's photograph not received as this issue goes to press

By HUGH RODMAN
Field Engineer
Universal Oil Products Co.
Chicago, Ill.

INSTRUMENT companies waste thousands of advertising dollars by the use of advertising copy which is unsuitable in the very fields which they solicit. The writer makes this statement because he knows personally that experienced instrument users scanning technical-journal advertisements seldom find anything in the instrument ads to teach them new facts about the manufacturers' products; and because he knows inferentially that instrument manufacturers advertise to instrument users (you don't see industrial instrument ads in *Good Housekeeping*).

Advertising addressed to us instrument users should be educational, especially now in war-time. But it should not teach us to recognize certain ads for the sole purpose of passing them by unread. Most of us know now which companies have instructive advertising and which do not; and we know the style of each. Pictures of noteworthy panel boards are instructive and even belong on the cover of *Instruments*; but ads made up of pictures of ordinary panel boards—even in prominent customers' plants—do not impress us because they do not instruct us. Such pictorial ads are of interest to no one who is not already familiar with the particular installations. Pictures of the faces of new instruments appear often; pictures of their working parts seldom; technical explanations almost never. And when we write for the advertised bulletin we often find it has enlarged pictures of the new case, or panel board, but little of the working mechanism or principles. Some of us have learned not to write for the bulletins.

Many instrument companies have a large enough line of products to run a series of cuts of the working parts of their instruments, diagrams of applications (especially un-

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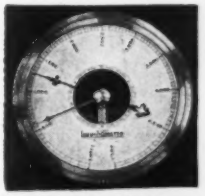

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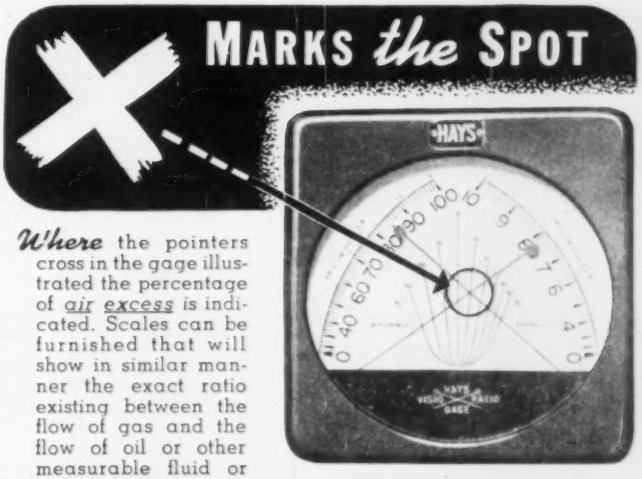

Where the pointers cross in the gage illustrated the percentage of *air excess* is indicated. Scales can be furnished that will show in similar manner the exact ratio existing between the flow of gas and the flow of oil or other measurable fluid or

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between any two of the following functions: pressure, draft, suction, temperature (up to 1000° F.) speed in R.P.M. or inches per minute, position, level, etc. Has many uses in steel mills, gas producing plants, heat generating plants, CO_2 generating plants, sewage plants, chemical plants, kilns, air-conditioning and others. Write us and learn how this newest Hays gage may be applied to your own flow measurement problems.

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usual ones) and detailed explanations; but they seldom do. This method would have inestimable value at the present time in educating those persons who, because of the war and its dislocations, must assume the responsibility for selection and care of instruments new to them.

[EDITOR'S NOTE—This is a hot potato. Arguments could rage endlessly. The only point we wish to clarify is in regard to *Instruments*' front-cover photos: chief requirement is that the significant portion of the submitted photo should have a width-to-height ratio of 5 to 4. Next, we look for "atmosphere" but we can't define this elusive attribute. Next, "pictorial value" which we can't explain either. Next, variety from month to month. When these and other obvious requirements have been met, the photo turns out to possess "educational value" . . . which we did not deliberately seek!—MFB]

Sources of Information for Instrument Dep't Personnel

See page 6 for photo of author

By EUGENE BAINBRIDGE
Instrument Man
Cities Service Company
East Chicago, Indiana

EACH instrument mechanic should be well aware of the world of information that is at his fingertips. This information is usually furnished free of charge to men in various lines of instrument work by the companies engaged in the manufacture of measurement and control equipment.

Men are usually chosen for this work who have a mind adaptable to rapidly-changing ideas and a desire for additional learning. This desire should lead them to the study of instruments. When a person realizes that for any particular problem that may arise, be it measuring or controlling, there is an instrument adaptable to this use, he should realize also that the manufacturer of any instrument is glad to furnish details of construction and operation.

The rapid advancement of instrumentation in industry is due largely to the forethought of many a manufacturer in conducting schools for the men concerned to learn the theory and mechanics of their instrument. This practice, although a splendid idea, has its disadvantages in that a great amount of time must be spent in individual instruction; whereas a man who has chosen to follow the course of instrumentation can, with the use of the information at hand, outline a self-study course that will carry him through the simple and elementary principles of instrumentation into the more complex control problems.

Instrumentation in the Engineering College Laboratory

By E. G. MAHIN
Head of Metallurgy Department
University of Notre Dame
Notre Dame, Indiana

WATCHING an instrument infallibly sort colors, coat, roll and wrap photographic films, record the positions of the atoms in a crystal, control and record furnace temperatures, or any one of the thousands of other precision operations, one is often tempted to repeat the old trite remark "It seems almost human." But it is no compliment to a fine machine or to a precision instrument to call it "almost human." The superiority of the human mind rests in its imagination, which conceived the machine, and in its creative genius, which made a reality of the mental process, and not in its ability to repeat, endlessly and without deviation, a given task requiring precision.

Instrumentation is at the heart of all scientific and engineering development. Human genius creates the instrument which then carries on its assigned task, leaving the human creator free for other problems.

An important part of the work of the teacher of engineering is to instill into his students an appreciation of the part to be played by his instruments and a hearty respect for the instrument which carries out his will so faithfully. An occasional student acquires this appreciation and this respect; and this student usually proves to be the man who later strives to improve the available instruments and to create better ones. It thus becomes a matter of the highest importance to see that the engineering college laboratory is equipped with properly chosen and well kept high-grade instruments. From this, industry and national defense benefit to a degree out of all proportion to initial and maintenance costs.

Pratt Institute's Instrumentation Courses

By A. W. DOLL
Supervisor
Course in Mechanical Engineering
Pratt Institute, Brooklyn, N. Y.

WHEN, several years ago, the engineering faculty of Pratt Institute studied the content of its present degree courses, the committee on the curricula appreciated the importance of organized instruction in instrumentation. As a result of this study, all seniors in Mechanical, Electrical and Chemical Engineering have had included in their curriculum since 1937 the course "Engineering Measurements and Standardization." Such a subject could be taught as a design course, or as a laboratory course, or as a combination of the two. At Pratt, it is a one-semester course with two hours classroom, three hours laboratory and one hour laboratory preparation. The following tabulation may give some idea of the material covered:

Precision of Measurements	Spectroscopy, Photometry
Temperature	Gas Analysis
Pressure (and vacuum)	Hydrogen Ion Determination
Length and size (Gaging)	Humidity
Speed and Time	Flow of Fluids
Sound	General Theory of Control
Oscillography	Recording & Control Mechanisms
Color, Spectrophotometry	Miscellaneous Instruments

Each topic is considered from three viewpoints: *(a)* Measuring, *(b)* Recording, *(c)* Control. Temperature is studied in considerable detail not only because of its own importance, but also because it serves so well to illustrate the general theory of control.

The school at the present time is offering an evening course in instrumentation under the sponsorship of the government's ESMDT program.

Instrumentation—One of the Pillars of Engineering

By CARL F. KAYAN
Assistant Professor of Mech. Engrg.
Columbia University
New York City

A NEW horizon looms up before us. Future engineering production will be required on a scale as never before imagined. With it will go the requirement of increased instrumentation, and as a corollary to this, more automati

control. Even if process variables could be adequately controlled manually, still release of man power to fields urgently requiring it will demand wide extension of automatic process control.

To this end engineering education must constructively contribute, must of necessity make some shifts. Hitherto, beyond the cultural socio-economic studies of general engineering, conventional curricula in mechanical engineering, for example, have stressed machine design on one hand, and energy analysis from the viewpoint of fluide- and thermo-dynamics on the other hand. These have been recognized as the Pillars of Engineering, but to these should be added another—Instrumentation, including the field of automatic process control.

Admittedly some schools have already recognized this. To a limited extent courses have included work on measurement of engineering properties and quantities, and some automatic control. Too often the treatment has been merely incidental, in passing.

Instrumentation, coupled with automatic process control, has come of age. Its very nature now requires a prominent position in a curriculum, with a sequence of courses and with laboratory facilities permitting investigation of characteristic equipment performance in dynamic processes. This implies study of the application of rational principles to automatic process control—not only of segregated processes but also of integrated system, and obviously in conjunction with energy analysis and machine design.

From the viewpoint of the Nation's immediate welfare, engineering schools should lose no time in giving Instrumentation the attention it must have, not only by developing rational courses for the regular students, but also in setting up Defense Training courses for those already in industry.

Some Specific Needs of Technological Libraries

By ERNEST I. MILLER
Chief, Technology Department
The Public Library
Detroit, Mich.

ANY statement I would prepare would be merely a reiteration of an editorial you wrote in the February 1941 issue of *Instruments* pointing out the need for general texts on the care and maintenance of fine instruments. Not texts for the college class room but for the foreman and the job training instructor—these are what we need.

I would broaden the field and include elementary inspection devices. We are having many calls for texts on micrometers, such as the Brown & Sharpe Company handbooks—more calls, in fact, than we can hope to supply. Perhaps it would be feasible for *Instruments* to print as a supplement an instruction manual for basic measuring instruments. If printed as a supplement we could remove it, place it in a separate binder and use it as a circulating book. (We hesitate to loan magazines since they are so easily lost.) The supplement idea might well be extended to other types of instruments. Issues devoted to one subject, such as your Aviation issue in October and Level Control in November, are also helpful.

Another need, which I believe you have also voiced, is for a cumulative index to the educational literature put out by our manufacturers. Monthly listings in journals are useful but we can't always anticipate our needs. (Incidentally, the listing in *Instruments* is among the most satisfactory for libraries since you give paging and size.) Technical librarians are much more conscious now than formerly, of the value of manufacturers' literature.

The search-lights of tonight that can locate flying death in the heavens are far different equipment from the much publicized lights that guided gun fire on Admiral Dewey's ships. Improvements in search-lights during the past fifty years have been comparable with improvement in all electrical equipment. It has been the privilege of the Ward Leonard organization to design and build most of the controls for search-lights through the entire development period. It is not surprising, therefore, that this inva'uable experience should be enlisted by our government.

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8—INSTRUMENT COMPANY TRENDS

Permanent Improvement in Men, Methods and Materials Is Reported

By R. S. PERKIN
President
The Perkin-Elmer Corporation
Glenbrook, Conn.

PRIOR to the Emergency, we were making a variety of high-precision optical items—roof prisms accurate to a second of arc, flats good to a twentieth of a wave, lenses for the most exacting scientific uses. When, however, these products became so vital in such large quantities, it was necessary to look for improved ways of manufacturing and testing them. The problem could not be solved just by hiring more men if each new man had to be an experienced and highly skilled optician. The solution has come partly through a constant revision of methods away from the hide-bound school of optical thought, and partly through the discovery (new to us, at least) that young American workers can get the "feel" of extreme precision with gratifying promptness, even when their previous trades seem totally unrelated to optical or mechanical work. We are glad to report that in addition to American workers, we can rely upon the raw materials supplied to our trade by this country. Optical glass, for instance, is as fine as any formerly obtainable from other countries, and its uniformity is considerably superior. We feel therefore that the stimulus of emergency conditions has caused a permanent improvement in the men, methods, and materials of our work.

Instrumentation in Mass Production Is Announced

By ALLEN D. MacLEAN
Vice President and Chief Engineer
Pittsburgh Equitable Meter Co.
Pittsburgh, Pa.

ONE of the less glamorous, yet essential, aspects of instrumentation is the production of measuring and control devices in large quantities. Many instruments are installed and operated by engineers and receive expert care so that difficult jobs of measurement and control are accomplished. But there is another side to instrumentation: in many industries equipment must operate continuously and efficiently without expert supervision; yet the same degree of accuracy is expected as from continuously-supervised installations.

This adaptation of instrumentation principles to mass production and field work is essential in our industry. For example, recent years have witnessed great strides in design and materials to increase the accuracy and efficiency of "ordinary" water meters and gas meters. A recent water meter utilizing a new principle has greatly extended the range of measurement with accuracy for the ordinary domestic water meter. Special machinery to generate impellers and other parts required a development of several years. The result is a highly accurate and satisfactory mass-production instrument.

In the field of oil and gasoline measurement a meter employing a radically new principle has made it possible to measure petroleum products at many points where previously instrument measurement was too delicate and measurement by the previous commercial meters was inaccurate. This device, too, is in mass production and required the development of special machinery.

In the field of gas measurement, new pressure-correcting instruments and temperature-correcting instruments have given the industry rugged and trouble-free devices at the low cost made possible by mass production methods. Ordinary domestic gas meters have been improved in design of details and materials. One of the most important forward steps in the field of domestic gas meters has been the working out of methods based on moving assembly lines which enable a much cheaper and more accurate final assembly. This is a good illustration of using methods which cut the cost of production yet improve quality.

In the field of pressure control, the most accurate and sensitive performance was obtained from the use of pressure coils, bleeds, etc. This type of instrumentation was really not rugged enough for the average gas company. A recent development makes available mass-production regulators in all sizes which have the sensitivity of instrument control yet are extremely rugged and requires no particular skill for field maintenance. Thus the gas industry now has an extremely accurate and sensitive device with which all points in the transmission and distribution system proper can be held precisely to the value desired.

The adaptation of control principles to mass production is an important step in many industries and one of the more notable advances in instrumentation in recent years.

Automatic Combustion Control for Sea-going Vessels Announced

By N. BELAEF

Mason-Neilan Regulator Co.
Boston, Mass.

RECENT developments in the application of automatic combustion control for sea-going vessels promise to grow into a field of considerable magnitude.

Factors adverse to the wide acceptance of the automatic control heretofore were: space limitation excluding bulky stationary systems, absence of suitable wide-range burners for oil-fired boilers, loading conditions varying from full speed to a crash stop, and absence of specially-adapted compact combustion system sufficiently flexible and simple which could withstand the rolling and pitching.

In recent years, as a result of collaboration between ship designers and combustion control manufacturers, the system specifically designed for the marine application has been perfected in actual trial installations, making possible greater efficiency, fuel economy, combustion without smoke, safety and minimum of manual attention. Function of the marine combustion system are:

to hold a constant steam pressure at all steaming rates,
to maintain correct oil-air ratio at all loads,
to preheat the fuel oil and to deliver it to burners at constant pressure,
to keep boiler level reasonably constant,
to protect boiler system in case of failure of auxiliaries,
to provide means for alternate manual operation of dampers and valves in case of emergency.

The functioning of the system is based upon the variation in the boiler steam pressure which determines the rate of combustion by actuating the draft controller which governs

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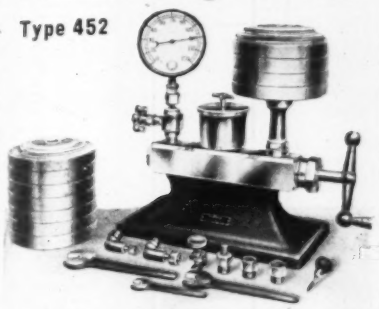
Type 452



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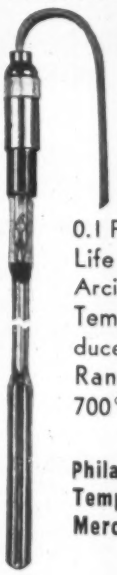

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the dampers setting, and hence the differential draft across the boilers.

The draft-oil pressure controller actuated by the changes in the differential draft controls the return oil pressure from the burners which automatically determine the quantity of oil burned in relation to the draft. The controller is adapted to operate with a number of different burner tips as may be required at different steaming rates.

For proper circulation the fuel oil is preheated and its temperature controlled. Other controllers are used for the maintenance of constant fuel oil pressure, boiler level, safety alarm, and manual operation of dampers and controlled valves.

The marine combustion system is proving its value in many classes C-1, C-2, C-3 vessels now at sea and under construction.

At this time when fuel economy is of great importance, the wide use of automatic combustion control in sea-going vessels should prove to be of real value, and the new developments are being watched with great interest.

Company Makes Start On Standardization of Instruments

By PAUL MacGAHAN
Development Engineer, Meter Division
Westinghouse Electric & Mfg. Co.
Newark, N. J.

LOOKING back over a lifetime of developments in instruments, one is forcibly struck by the increase which has occurred in the variety of types and sizes. During these years electrical measurement has entered a great many new fields unthought of at first, even as a tree naturally develops branches. These new fields have necessitated new methods and new kinds of instruments. The result is that the manufacturer and the industry are confronted with a myriad of types and variations, which individually may not amount to enough to justify an all-out engineering and tooling development, but which in the aggregate amount to a large volume of output.

This is in strong contrast to the situation on watthour meters. There it was a case of measuring only one thing—energy, and for one purpose only—billing for service. Thus such a high degree of standardization was accomplished that all American manufacturers' meters are identical in size and mounting, if not quite identical in their interior workings and quality.

The dream of the instrument manufacturer is to be able to approach even remotely, such a standardization, because the great multiplicity of types handicaps the achievement of the most desirable production and cost conditions. As stated in a recent letter by President Prince of the A.I.E.E., "During the present emergency, standardization takes on a new significance." The same theme was the basis of the address by Lessing J. Rosenwald at the annual luncheon of the A.S.A. in New York on December 10.

Varieties of measurement jobs required of instruments are a noble increase fully necessary and justified. Not only are instruments "the eyes of Industry" but they are tremendously essential in the War Effort.

But can as much be said of the great variety in sizes and shapes that each manufacturer has been forced to make by his customers' demands? While some such variations are essential—2" diameter minature sizes as well as full-size switchboard types, portables or recorders—what, after all, is the necessity for having several types in each size? For example, many instrument manufacturers build indicating instruments, not only in the 2", 3" and 4" case size classifications but also make each of these in round, square, flush or projection type cases. The difference in scale length between the smallest of these and the largest is only 50%. The same condition is largely true in the conventional large switchboard instruments having scales approximately 6" long. They also are made in round, square, flush and projection cases.

Manufacturers produce only what their customers demand. They have no desire to split their production into many varieties. Therefore standardization must start with the purchaser.

In the face of existing variations and lack of standardization in the demands of the purchasers, the company with which the writer is affiliated has evolved an interesting development which has been aptly termed the "Chassis Construction."

In this arrangement a complete line of all kinds of miniature instruments from the smallest 2" line to the largest, consists of chassis, covers, dials and accessories. There are three basic sizes of chassis, comprising a molded base complete with the measuring element, and for each size there are four forms of interchangeable covers; namely, round or square projection, and round or square flush type. Dials, movements and accessories are interchangeable for all these shapes. Dials, springs and coils are according to capacity, the pointers varying in length according to the three basic sizes.

The result is an ability to assemble quickly on demand, with a few basic stock parts, over 48 distinct types, each comprising all standard capacities in a.c. or d.c. such as are covered by a total of 4350 listed styles. This is exclusive of special styles, and certain war types which are also, at least in part, readily assembled from the same basic elements.

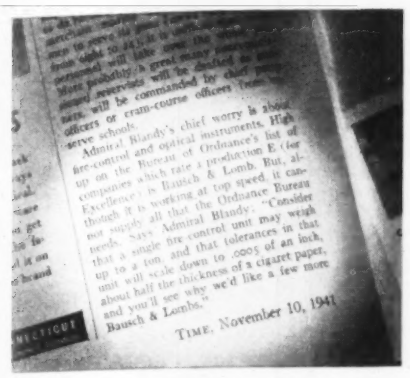
Gas Specific Gravity Meter Makes Heat-treating Furnace Safe

By ERIC PICK
Engineer
The Permutit Co.
New York City

THERE are today thousands of bell and pit type furnaces in use in this country, with more being installed every week to meet the mounting requirements of the War Effort. In both these types of furnaces the charge to be heat-treated is protected against contact with air by a cover resting in an oil seal, and the furnace atmosphere (usually prepared by partly burning gaseous fuel) nearly always contains sufficient hydrogen, carbon monoxide and hydrocarbons to make it highly explosive when mixed with air in certain proportions.

In the past the only precaution against explosion has been to purge the furnace with the special-atmosphere gas for a period of time found sufficient by experience. Then the electric or radiant-tube heating elements were turned on. Such haphazard operation brought about frequent explosions, as might be expected, when the furnace was insufficiently purged of air because of lowered gas flow, because of a leak, etc. Probably every operator has experienced such explosions in a mild form which do no more damage than to blow out the oil seal of the cover. Occasionally, however, serious explosions occur. In a recent case a bell type furnace blew the cover forty feet up against the roof, scattered twenty tons of furnace and charge, and seriously injured two men.

Such explosions can easily be prevented by the use of a specific gravity meter. The gas used as furnace atmosphere usually has a specific gravity within the limits 0.8 to 0.9. By continuously measuring the specific gravity of the gas-air mixture discharged from the furnace during the purging



officers or cram-course officers from the ranks, will be commanded by chief petty officers and reservists will be drafted as gunners. Admiral Blandy's chief worry is about gunnery officers. He is about to observe schools. . . . Admiral Blandy's chief worry is about fire-control and optical instruments. High up on the Bureau of Ordnance's list of companies which rate a production E (for Excellence) is Bausch & Lomb. But, although it is working at top speed, it cannot supply all that the Ordnance Bureau needs. Says Admiral Blandy: "Consider that a single fire control unit may weigh up to a ton, and that tolerances in that unit will scale down to .0005 of an inch, about half the thickness of a cigaret paper, and you'll see why we'd like a few more Bausch & Lombs."

TIME, November 10, 1941

Why Bausch & Lomb?

THE ability of Bausch & Lomb to produce the highly specialized optical instruments needed by the armed forces of the United States was not born of the present emergency. It has been acquired over eighty-nine years of research and unbroken experience.

Today the abilities and facilities and accumulated experience of Bausch & Lomb are being directed in their entirety to filling the needs of Production for Victory. Needed immediately are the instruments of which Admiral Blandy speaks — the rangefinders, binoculars, aerial height finders, and photographic lenses.

Vital as these are, there are others equally essential which Admiral Blandy did not mention. Among these are the spectrographic and metallographic equipments used in the analysis and quality control of cartridge cases and armor plate, the contour projectors and the tool-maker's microscopes for the fine measurements upon which mass production of tanks and airplanes depends. To help maintain health and efficiency, military and civilian, there are microscopes, diagnostic instruments and spectacles.

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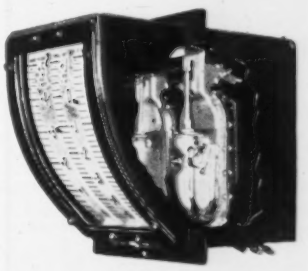

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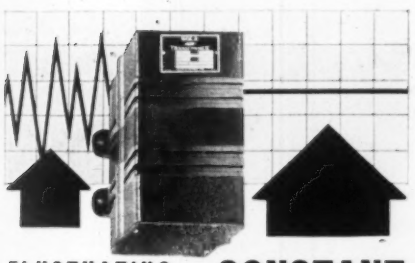

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operation, and continuing the purging until the specific gravity of the gases entering and leaving the furnace is substantially the same, definite assurance is obtained that the furnace atmosphere has become non-explosive. The specific gravity indicator and recorder made by the company with which the writer is associated has been found excellently suited for this work because of its ruggedness and exceedingly small time lag amounting to but a small fraction of a minute. In some cases this instrument has been equipped with an electric contact so wired into the controls of the furnace that the heat cannot be turned on until the atmosphere is safe.

Not only does this specific gravity meter safeguard against explosion, but it also increases the capacity of the furnace by making it unnecessary to provide for a safety factor in the purging time, and it makes it possible to detect slight contaminations of the furnace atmosphere not large enough to cause an explosion but sufficient to spoil the heat treatment.

Radio Telemetering System Is Announced

By FRED LEUPOLD
Manager
Leupold, Volpel & Co.
Portland, Ore.

IN many instances the automatic recording of the position of any moving element by radio has decided advantages over other methods. For example, in the manipulation of gates at flood control structures it is important to know as early as possible any incipient storms that may be brewing. One method is to have a transmitting station on the principal tributaries of a reservoir connected to the control house at the dam by radio.

Carrying this point further, in an endeavor to secure even earlier information than the streams themselves may give, is to establish one or two key precipitation stations on the drainage area and have the precipitation registered by radio at the control house.

We have developed such radio recording equipment. A power source is of course essential at the transmitting end and the most practicable source is by means of storage batteries. In order to keep these batteries charged a wind charger is furnished; otherwise it would be necessary to visit the station once a month or oftener to replenish the power source. The new radio recorders have been developed in such a manner that practically all effects of static have been eliminated. Records are made on a ticker tape by code, each set of signals occupying about 6" of tape. On this length appear the station call letters, the water levels or precipitation and the exact time of day, hour and minute in which the signal is registered. All of the stations are registered on the same tape, there being merely an identifying number as a part of each call letter. This is accomplished by staggering the times of registration among the stations. On river stations registrations can be made in any desired time intervals; for example, once in every 12 hours below a certain predetermined stage and once every hour above that stage.

For precipitation recorders the snow-rain recorder used as the moving element may have a capacity of 100" of equivalent liquid precipitation and it doesn't matter whether it falls as rain or as snow. Broadcasts can be made at any time desired, daily, 12-hour periods, or every hour.

A radio registering system consists of five pieces of apparatus and a power source. At the transmitting end there is a transmitter which broadcasts the signal; a coding device; also a time switch which may be a weight-driven clock set to turn on the broadcasting system at predetermined times. At the receiving end there are two pieces of apparatus—the radio receiver and the radio recorder. If a precipitation record is desired, a snow-rain catching and weighing device is necessary at the transmitting end in addition to the three pieces listed above.

Geophysical Instruments and the Critical Minerals

By J. C. HOLLISTER
Engineer
Heiland Research Corporation
Denver, Colo.

IN these days of priorities and restrictions produced by shortages of the critical minerals, the question of how to make these minerals less critical naturally arises. Some of these minerals, such as the copper group, are plentiful enough and need only increased production. Others require only improved refining methods or the discovery of larger deposits from which to draw. It is within this last group that instrumentation is playing its part.

In the metallurgical laboratory and the recovery plant instruments are indispensable for test, analysis and process control. They are beginning to assume an active part in prospecting.

For a decade the most useful single tool for the petroleum geologist, the seismograph now is being employed, along with the gravimeter, magnetometer, and electrical prospecting devices, as the willow wand in the location of new and the extension of old deposits. Both private and government agencies are conducting geophysical surveys in a search for one of the most restricted of the critical minerals—bauxite, since from bauxite comes most of our aluminum.

By the application of geophysical methods to the search for other minerals, and by the development of new geophysical and metallurgical instruments we will be able not only to relieve present shortages but do a small part toward shortening the conflict into which we have been drawn.

Magnetic Analysis Inspection of Bar Stock and Tubing

By THEODORE ZUSCHLAG
Chief Engineer
Magnetic Analysis Corporation
Long Island City, N. Y.

INCREASING use of higher quality steel has resulted in a demand for economical production type inspection methods suitable for the checking of such steel with a speed and accuracy much higher than required only a few years ago. Most promising among the methods considered for this purpose is Magnetic Analysis, commonly defined as the non-destructive inspection of ferromagnetic objects by electric and magnetic methods for variations in non-magnetic properties.

Present commercial applications of magnetic analysis are restricted to the testing of ferromagnetic material of uniform cross-section. Magnetic analysis excels in the high-speed inspection of bar stock and tubing for qualitative uniformity including changes in analysis, heat treatment

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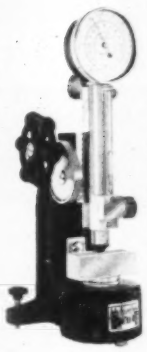

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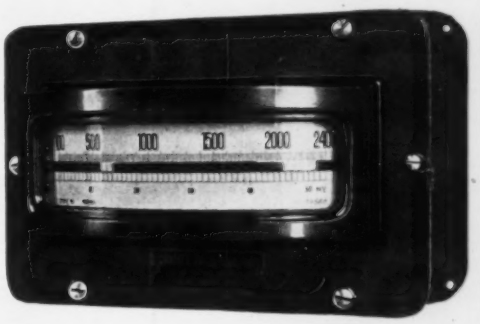

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By G. W. STUBBINGS

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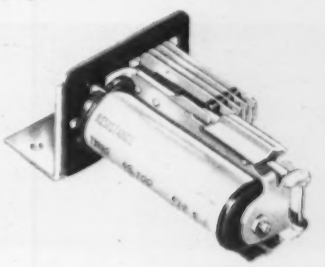

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